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Taxonomic-Ecologic Studies of the Boletaceae in Northern Idaho and Adjacent Washington¹

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This paper is the first product of an investigation by the senior author of the ecological relationships of the forest fungi of northern Idaho and adjacent Washington. At this time the Boletaceae appear to be the first group adequately represented in collections made in the course of the study. It is anticipated that other boletes will be found, but the 23 species discussed here are believed to represent the majority occurring in the region, since in the past two seasons no additional species have been observed.

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² Responsible for conduct of the project, and author of the manuscript.

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The study has been conducted thus far on the Kaniksu National Forest in Bonner County, Idaho, and Pend Oreille County, Washington, between the ridge of the Cabinet Mountains east of Priest Lake and the Pend Oreille River in Washington. No investigations have been made south of the Pend Oreille River in Idaho, or north of Hughes Meadows, Bonner County, Idaho, which lies about 10 miles south of the Canadian border. The area covers approximately 1400 square miles, virtually all of which is typical "white pine region" forest land. The term "white pine region", in the United States, has been applied to the area roughly including that part of Idaho north of the Clearwater River, west of the Bitterroot divide, and south of the Canadian border, and also the Cabinet and Kootenai River Mountains in northwestern Montana, and Pend Oreille County, Washington.

ZONATION AND SUCCESSION

The forest vegetation of the region comprises four distinct altitudinal zones, named for the species dominating the climax associations (Daubenmire, 1943). In order of increasing altitudinal position these zones are: *Pinus ponderosa* zone [*P. ponderosa* Douglas], *Pseudotsuga* zone [*P. taxifolia* (Lambert) Britton], *Thuja-Tsuga* zone [*Thuja plicata* D. Don and *Tsuga heterophylla* (Rafinesque) Sargent], and *Picea-Abies* or subalpine zone [*Picea Engelmanni* (Parry) Engelmann and *Abies lasiocarpa* (Hooker) Nuttall]. The first two are comparatively poorly represented in the region since it is so far from the arid basal plain to the southwest, around the borders of which *P. ponderosa* and *Pseudotsuga* reach their optimum development under semi-arid climate in the Columbia basin. In the moist region where the study has been conducted climax stands of *P. ponderosa* and *Pseudotsuga* occupy exposed, dry sites on south and southwest slopes, constituting a climax in which topography is the controlling factor; i.e., a topographic climax. The greater part of the forest area of the region is in the *Thuja-Tsuga* zone, and it is with this zone that the study is concerned. The *Picea-Abies* zone occupies the higher ridges, usually above 4500 feet elevation, although the southerly slopes of high, extremely exposed ridges support a grass-bald climax.

Although the four zones are altitudinal in their sequence, their limits in terms of elevation above sea level overlap greatly, since topography strongly affects the zonal pattern. Frequently, isolated segments or upward extensions of the *Pseudotsuga* zone occur even as high as the lower limits of the subalpine zone, where slope and exposure render the site too severe to support *Thuja-Tsuga* associations. Small stands of *P. ponderosa*, accompanied by many of the subsidiary species comprising this climax, extend up to relatively high altitudes on south-facing rock outcrops where soil is thin and exposure unusually severe. Likewise, long fingers of the

Picea-Abies zone extend down into the *Thuja-Tsuga* zone along the drainages on northerly slopes, where water relationships are maintained within the requirements of this association.

In the *Thuja-Tsuga* zone the arborescent components of the climatic climax may vary somewhat with seed source, historic factors, and perhaps edaphic conditions, but include *Thuja plicata*, *Tsuga heterophylla*, and *Abies grandis* Lindley. *Taxus brevifolia* Nuttall and several lower shrubs and forbs are equally typical of this climax, but all are not listed here since the tree species serve to characterize the associations. In some parts of this zone one of the three characteristic climax dominants may be rare or missing. The zone includes, in the seral association, *Pinus monticola* Douglas, *P. contorta* Douglas var. *latifolia* Engelm., *Larix occidentalis* Nuttall, *Pseudotsuga taxifolia*, and rarely *Pinus ponderosa*. *Pseudotsuga*, although a climax species in the next lower zone or on drier sites, as indicated above, frequently is an important component of seral communities in the *Thuja-Tsuga* zone. On the other hand, *P. ponderosa* is rather rare in seral communities. With the exception of the latter, most seral stands contain all of these species and are usually dominated by one of them, thus forming a consociation. Some consociations, however, lack one or more of the seral species.

The successional pattern on secondary bare areas resulting from fire in this zone appears to be controlled largely by the immediate seed source. Usually burns develop stands of *P. contorta* var. *latifolia* or *Larix*, or both, as the first forest cover, primarily because the former has serotinous cones and the latter is strongly fire resistant. Burns rarely seed immediately to the climax species only. Frequently *P. monticola*, *Pseudotsuga*, *Thuja*, and *Tsuga* all appear along with *P. contorta* var. *latifolia* and *Larix*, or they may become established after some cover develops. Young stands in which all these species are present and of the same age often appear to consist almost exclusively of *P. contorta* var. *latifolia* or *Larix*, or both, since these species grow comparatively much more rapidly. These pioneers soon decline, the majority of the former dying out by the time the *P. monticola* has overtopped them. *Larix* often persists as relic individuals in the developing stand of *P. monticola*, *Thuja*, and *Tsuga*, but most of the *Larix* disappears from even moderately closely stocked stands before reaching 60 to 80 years old. Rarely individual *Larix* persist until the stand has reached essentially climax composition. *P. monticola* almost invariably achieves numerical dominance following decline of the *Larix* in the succession on most areas. The climax tree species, whether they germinate at the same time as *P. monticola* or enter later, develop beneath this last seral consociation. By the time the *P. monticola* is overmature all seral shrubs and forbs have also disappeared and are replaced by climax species.

Relative frequency	THUJA-TSUGA ZONE				PSEUDOTSUGA ZONE	
	Seral associations					
	<i>Epilobium</i> association on new burns	<i>Pinus contorta</i> var. <i>latifolia</i> consociation	<i>Larix occidentalis</i> consociation	<i>Pinus monticola</i> consociation		
Most common species	None observed	<i>Suillus granulatus</i>	<i>Suillus elegans</i> <i>Boletinus ochraceoosens</i> <i>Bol. cavipes</i>	<i>Suillus elegans</i> <i>S. granulatus</i> <i>Boletinus cavipes</i>	<i>Thuja-Tsuga</i> climax association	<i>Pseudotsuga</i> topographic climax association
Intermediate	None observed	<i>S. ? subaureus</i>	<i>S. aeruginascens</i>	<i>S. aeruginascens</i> <i>S. hirtellus</i> var. <i>mutans</i> <i>S. subluteus</i>	<i>Xerocomus Zelleri</i> <i>Boletus mirabilis</i>	<i>Boletinus anabilis</i>
Comparatively rare	None observed	<i>S. hirtellus</i> var. <i>mutans</i> <i>S. elegans</i> <i>S. subluteus</i>	—	<i>Bol. ochraceoosens</i> <i>S. americanus</i>	<i>X. subtomentosus</i> <i>X. ? pulverulentus</i>	—
Observed once only	None observed	—	<i>S. luteus</i> <i>Bol. ? appendiculatus</i>	—	<i>B. edulis</i> <i>B. fragrans</i> <i>Suillus granulatus</i> <i>S. hirtellus</i> var. <i>mutans</i>	—

BOLETES IN RELATION TO THE FOREST ASSOCIATIONS

In the *Thuja-Tsuga* zone the flora of the climax association is fairly distinct from the floras of the consociations comprising the seral association. This feature has long been recognized with regard to the higher plants, and it is one of the aims of this investigation to determine whether or not the fungi are similarly limited to specific plant associations. The species of the Boletaceae described here have been found to exhibit such a distributional pattern, many of them appearing to be confined to a particular association. With the limited number of collections and observations the element of chance cannot be ignored, but observations in the Boletaceae are abundantly supplemented by similar sociologic behavior of local species of the Agaricaceae, the majority of which likewise appear to be limited to single associations.

Of the eight stations intensively collected in this study, two are in burns which were less than two years old when work was begun and which support an herbaceous association dominated by species of *Epilobium*. Two are in climax *Thuja-Tsuga* stands, one is in the *Pseudotsuga* topographic climax, and the remaining three in seral forests. Each of these latter stands contains all species found in the seral association, but each is dominated by a single species and forms a consociation. The consociations differ but little in their vegetational potentialities, all showing ample evidence that they are progressing toward *Thuja-Tsuga* climax associations. These three stands, and others like them throughout the region, support essentially the same bolete flora, but the frequency of occurrence of species differs considerably among them. The accompanying table shows the boletes occurring in each association, including a rough comparison of frequency.

As indicated in the table, no boletes have been observed in the *Epilobium* association on recent burns. In the *Pinus contorta* var. *latifolia* consociation *Suillus granulatus* is the most characteristic bolete species, and is also one of the most common of the higher fungi. In the *Larix* consociation three species characteristically appear with approximately equal frequency: *S. elegans*, *Boletinus ochraceoroseus*, and *Bol. cavipes*. Somewhat less common is *S. aeruginascens*. The close similarity between the *Pinus monticola* and *Larix* consociations is indicated by their similar bolete floras. *Suillus granulatus* replaces *Bol. ochraceoroseus* among the commonest species in the former, and three other species are found here which have not been observed in the *Larix* consociation.

The bolete flora of the *Thuja-Tsuga* climax association is shown in the table to differ radically from that of the seral association. The most common species here are *Xerocomus Zelleri* and *Boletus mirabilis*. In this region to date, the genera *Xerocomus* and *Boletus* appear to be confined to the climax association in the *Thuja-Tsuga* zone, with rare exceptions. Only a single collection of one species of one of these genera has been found in a seral association, that species being 16. *X. sp.*

Boletinus amabilis is the only bolete species observed to date in the *Pseudotsuga* topographic climax. Near the ecotone, however, where tree species typical of the *Thuja-Tsuga* zone appear, other boletes common to the seral forests have been observed. *Bol. amabilis* is common also in the seral forests wherever *Pseudotsuga* is present.

MYCORRHIZAE

The boletes are of interest to foresters as well as mycologists because they constitute one of the few groups of the fungi which have been shown to contribute directly to the nutrition of forest trees through their mycorrhizal relations. Many species of the Boletaceae have been demonstrated to be fungal components of mycorrhizae, experimentally in culture, and by the somewhat less certain method of tracing mycelial connection between fruiting bodies and mycorrhizae *in situ* (e.g., Young, 1936, 1940; Hatch and Hatch, 1933; Peyronel, 1920, 1922; Romell, 1921; Melin, 1922, 1923a, 1923b; Masui, 1926; Doak, 1934; Rayner, 1938; How, 1940, 1941, 1942; and others). It is probable that all boletes are components of these relationships.

There is little doubt that the occurrence of certain boletes in a given association is controlled by the mycorrhizal relationships of the species concerned. Regardless of the cause, it becomes increasingly apparent as the study progresses that these species are important and regular constituents of their respective associations. Food relationships of the fungi constitute perhaps the most important factor controlling their associational distribution, but present lack of knowledge of this complex field does not allow more than speculation concerning the causes of their distribution, or the factors governing their maintenance as components of the communities.

Known mycorrhizal associates among the species treated here are indicated in the detailed species descriptions. The references cited do not constitute a complete bibliography of mycorrhizal association. No effort has been made in this study to trace mycelial connection between boletes and tree roots, but detailed records were kept of the trees within fifty feet of the majority of the fruiting bodies in each collection, thus presenting some circumstantial evidence of their possible mycorrhizal relationships.

EFFECT OF ASSOCIATION AND ENVIRONMENT UPON INTRA-SPECIFIC VARIATION

Peyronel (1922) has noted variations in *Leccinum scabrum* (*Boletus scaber*) which he believes may be due to the mycorrhizal associations of the various forms. There appears to be a change of form, size of the pileus, and diameter of the stipe, depending upon whether the species is mycor-

rhizal upon *Betula alba*, *Corylus*, *Quercus*, or *Castanea*. He further states that *Boletus rufus* (= *Leccinum aurantiacum*) is probably only a form of *L. scabrum* which forms mycorrhizae on *Populus tremula*, and he points out that such variation is of considerable taxonomic significance. There is good reason to doubt Peyronel's suggested synonymy, but that he recognized the potential taxonomic importance of such variation is worthy of note.

There has been relatively little investigation of the part played by climatic and other environmental factors in determining intra-specific variation in the fungi, although many have recognized the possibility that variation may be so effected. Observations by the senior author during the past four years indicate that variation both in immediate environment and in climatic conditions may account for many differences between individual collections of certain species, although at this time no specific data can be presented. Differences in viscosity in many species of boletes are obviously due to conditions of humidity and precipitation under which each collection has developed. *Suillus americanus*, although found twice in the same place, exhibited such differences between the specimens collected that identification was puzzling. Specimens of this species found during the unusually wet fall of 1940 (Plate 4, fig. C) showed large areas of red to brownish red gluten on the pileus and a definite annulus, the latter not reported from any other region. Also, the interior of the stipes at the base turned to blue when cut. Collections from the same spot made during the unusually dry fall of 1942 (Plate 4, fig. B) showed very small streaks of reddish color on the pileus and many had none at all, and only rarely was there even a trace of an annulus. The stipe interior in these latter collections showed no change to blue, but only a slight roseate tint when cut, entirely typical of the species as found in the eastern United States. All collections of this species in this region have a large and distinct hollow at the base of the stipe when mature, a feature not reported in eastern collections.

Boletinus ochraceoroseus appears considerably paler than usual in a season with much rain and little sun. Specimens seen in the spring of 1941, when there was comparatively little sun until late in June, were uniformly pale pink, while collections made in the spring of 1939 and 1940 were much darker, apparently because of higher total insolation, at least in part. Repeated observations of this phenomenon were made over the region in each season, since it is one of the more common species.

Such observations, unsupported by quantitative data, are obviously somewhat speculative, but similar variation has been observed in other groups, notably the Agaricaceae. As the study progresses it is the intention of the senior author to accumulate data which may cast more light upon such phenomena.

DISTURBANCE OF THE SUBSTRATA

Many species of boletes fruit most commonly along roadsides, ditches, road cuts, and trails (e.g., *Xerocomus* ? *pulverulentus*, 16. *X. sp.*, *X. subtomentosus*, in this region). Others fruit chiefly on the undisturbed forest floor (e.g., *Boletus mirabilis*, *Boletinus amabilis*, *Suillus elegans*, *S. ? subaureus*, *S. granulatus*, *S. subluteus*, *S. luteus*, and *Leccinum scabrum*). Still others appear to occur with approximately equal frequency on disturbed and undisturbed substrata, including *S. hirtellus* var. *mutans*, *S. americanus*, *S. aeruginascens*, *X. Zelleri*, *Bol. cavipes*, and *Bol. ochraceo-roseus*. Early in the study these differences became evident to the senior author and it now appears that occurrence on disturbed or undisturbed substrata is almost specific for several of the species found in the region.

DESCRIPTION AND HANDLING OF COLLECTIONS

Species of the Boletaceae present many problems in collection and preservation. They are soft, fleshy, often rather watery, and change appearance so rapidly that it is almost essential to complete description of color and configuration immediately as the collections are made, or at least within a very few hours. In this study a mimeographed record sheet, including essentially the information given in the detailed species descriptions, is filled out as each collection is made. A cast of spores from mature specimens in each collection is made on white paper and attached to the record sheet under a strip of transparent cellulose tape, thus showing the spore color in mass and providing a convenient method for determining tube mouth size. A small piece of this spore cast paper is folded with the spores inside and attached under cellulose tape to the record sheet to provide material for microscope slide mounts of naturally cast spores. Specimens are dried in a portable drying cabinet in which they are supported on wire-screen shelves over a pressure gasoline lantern, or by exposure to full sun. Dependence upon sun-drying ruins many specimens, since during the optimum season for boletes there is little clear weather and they either become riddled by larvae before they dry or are carried off by red squirrels, which utilize them extensively for food. When dry the specimens are placed in new kraft bags with a small quantity of paradichlorobenzene crystals to kill insects, and the bag is sealed with gummed paper tape.

SPECIES DESCRIPTIONS

The detailed descriptions of species presented here may be found to differ in minor degree from European and eastern North American descriptions. Such differences chiefly involve color, which in many boletes is extremely variable. Where such variable species have been found to possess but a limited color variation in this region, this restriction is indicated.

Two parallel methods of color description have been employed. Maerz and Paul (1930) color plates have been referred to for the convenience of those desiring a specific color reference. These colors are indicated as a combination of two numbers and a letter, in parentheses, e.g. (9K1), the first number indicating the plate, the letter giving the column, and the remaining number the line for the color specified. Actual comparison of specimens with the Maerz and Paul plates was not made in the field, the senior author relying upon memory of the numerous collections and observations of the species made, coupled with the field descriptions of the colors. The alternative color designation employs descriptive terms in more or less common use, but it is notably unreliable because of the personal factor in interpreting the terms. The latter method, however, is the only one practical in field identification.

When dried and preserved as herbarium specimens, boletes bear little resemblance to the fresh specimens. Shrinkage is almost always severe, frequently accompanied by extreme distortion. Surface characters are obscured in many species by wrinkling, or the specimens are otherwise altered seriously. Color is rarely preserved, most dried specimens undergoing such radical color changes that, unless one is well versed in the possibilities of color change, they give no inkling of the original color. For this reason the detailed species descriptions include the characteristics of local specimens when dried, colors being given both in general descriptive terms and as references to the color plates of Maerz and Paul (1930), with which the herbarium specimens of the senior author's collections were compared. A few species lack color references, where collections consist of a single specimen, or a single collection of only a few individuals, since one or two specimens may differ considerably from the average range of color for the species in the region. Although several species are virtually indistinguishable when dried, these descriptions of herbarium specimens may help to remove uncertainty in distinguishing others.

Species collected during this study which dry with a minimum of color degradation and shrinkage include *Xerocomus Zelleri*, *X. subtomentosus*, *X. ? pulverulentus*, 16. *X. sp.*, *Boletus mirabilis*, *B. frustosus*, *Boletinus ochraceoroseus*, *Leccinum versipelle*, *L. scabrum*, and *Suillus subluteus*. Others in which the original color may be indicated but shrinkage is often severe are *Bol. cavipes*, *Bol. amabilis*, *S. elegans*, *S. americanus*, *S. hirtellus* var. *mutans*, *B. fragrans*, and 17. *X. sp.* In the following both change of color and shrinkage are usually extreme: *S. luteus*, *S. ? subaureus*, *S. granulatus*, *B. edulis*, and *S. aeruginascens*.

It should be emphasized that similar behavior may not occur in specimens collected in other regions, an example of which is found in *B. mirabilis*, one of the best species in the region for retaining its original characteristics when dried. When it was first described from the humid Puget

Sound region, Murrill (1912, p. 98) stated that it was difficult to preserve because of its extremely juicy consistency. This is perhaps another instance in which environmental factors control variation in the characteristics of a species.

The discussion following each species description includes a statement of the season in which it has been collected or observed fruiting during the period of this study. It is not intended to imply that these species do not occur in this region at times other than those indicated. The climate of the region between the Bitterroot Mountains and the Cascades is characterized by summer drought. Although this dry period usually extends from about June 15 to September 15, differences in amount and incidence of precipitation occur frequently enough to upset generalizations based upon phenologic data covering only a few years. Total annual precipitation records are of little assistance in determining whether a given season has approached optimum moisture conditions, unless precipitation distribution is also considered. The spring rainy season may continue until late in July occasionally, or it may terminate in May. Fall rains may begin as early as mid-August, or they may not begin until just before freezing weather in late October. Moisture conditions in the substrata apparently determine date of first appearance and number of individuals of a species. The fall of 1942 was unusually dry, with only rare storms until a week or ten days before the first snow, near the end of October. Few boletes appeared, localities which usually support large colonies of several species producing only rare individuals. Agarics were also comparatively scarce. Many species of fleshy fungi common in a normal season were not encountered anywhere in the region. Species collected were those customarily appearing first each season, although the tardy beginning of wet weather apparently postponed their first appearance several weeks.

Seasonal temperature differences, above freezing, probably exert much less influence upon the date of first appearance of the earliest species than does amount and incidence of precipitation in this region. Given two seasons with similar precipitation patterns there is little doubt that a larger number of individuals, and perhaps even more species of fleshy fungi would appear in the warmer season, particularly in the spring, if moisture conditions were adequate. It is doubtful, however, that the difference in occurrence would be significant unless temperatures differed considerably. As a general rule a wet season is also appreciably colder.

Despite the limitations imposed by possible variations in moisture and temperature conditions throughout the region, the phenologic data presented may be expected to be substantially reliable in most seasons, with the exception of years in which gross abnormalities in climatic conditions occur.

ICONES

A list of selected icones has been compiled for those species which have been illustrated in the literature. It has not been possible to indicate which of these illustrations is most closely characteristic of the species as represented in this region, since a few have been unavailable for examination. Certain ones have been eliminated since they proved grossly unlike collections made in the course of this study.

The illustrations accompanying this paper are copies of a series of Kodachrome and Dufaycolor slides photographed by the senior author from specimens in his collections. These were made *in situ*, with a minimum of disturbance of the immediate environment, and are believed to be typical of the species as found in this region.

KEYS

Two types of keys are employed in this paper. The first is based on gross characters, ignoring generic differences, and was developed primarily for field use with the 23 species described. Although useful for field identification, this type of key may prove confusing if species are encountered which are not included in it, since their characteristics may lead to erroneous identification. It is urged that all specimens identified with the aid of this key be carefully compared with the detailed species descriptions. The second key is based on generic distinctions. It is distributed throughout the text, each of the five genera represented in the collections being treated separately. Characteristics found in the collections are emphasized in both keys, sometimes ignoring misleading characteristics as reported in other regions.

A synopsis of the genera of the Boletaceae as proposed by Snell (1941, 1942) is included. Sixteen genera are included in the family, only five of which are represented in collections made in this region to date.

Synonyms cited for the species described are the names commonly accepted prior to combinations according to Snell's (*op. cit.*) proposals.

BOLETACEAE—SYNOPSIS

Fleshy hymenomycetous fungi, stipitate, the hymenium lining tubes beneath a thick, usually convex pileus. Annual, terrestrial, or very rarely lignicolous.

Subfamily BOLETEAE—Spores smooth.

Tribe EUBOLETEAE—Spores long-elliptical or subfusiform, colored; hymenophore tubulate, boletinoid, or even lamellate; tubes compound or simple.

Genus BOLETINUS—Tubes arranged radially in rows, usually with more or less prominent veins between, at least when young; not easily separable from the carpophore and not at all from each other.

SUILLUS—Stipe not reticulate, except at the very apex or above annulus in a few forms; tubes adnate or decurrent, not free and not stuffed when young; pileus viscid when wet or at all times; spores elliptical.

XEROCOMUS—Pileus dry, never viscid, may be glabrous, subpruinose, or subtomentose; tubes simple or compound, never stuffed or with red mouths; spores subfusiform; stipe never truly reticulate or subbulbous.

BOLETUS—Fruiting body rather stout and robust; tubes simple; stipe stout and more or less bulbous, especially at first; spores subfusiform.

Sections:

CALOPODES—Stipe reticulate; tubes adnate, not stuffed when young.

EDULES—Tubes free, or if adnate then stuffed when young.

LURIDI—Tube mouths some shade of red. None collected in the region.

LECCINUM—Tubes white, at least at first, free or adnate, stuffed when young if the latter; stipe more or less slender and scabrous, tapering upward; spores more or less fusiform-elliptical.

The following genera were not collected in the course of this study.

PHYLLOPORUS—Tubes lamellate, anastomosing; spores subfusiform.

PULVEROBOLETUS—Pileus and stipe more or less pulverulent; tubes simple; spores small, ellipsoid to ovoid.

TYLOPILUS—Tubes and spores flesh-colored.

PORPHYRELLUS—Pileus pilose; spores reddish.

Tribe **GYRODONTAEAE**—Spores small and oblong to short-elliptical or nearly subglobose, colored; hymenophore more or less boletinoid and more or less lamellate; tubes short to very short.

BOLETINELLUS—Hymenophore very lamellate, merulioid; spores very broadly elliptical, thick-walled. One species only: *B. merulioides* (porosus).

GYRODON—Spores very small, short-ellipsoid.

Tribe **LEUCOSPORELLEAE**—Spores oblong or short-elliptical to narrowly ellipsoid, hyaline, white (?) or yellow in mass; carpophore imputrescible; tubes simple, at first white, then usually yellow; stipe hollow or solid.

GYROPORUS—Stipe not reticulate, spongy within, soon hollow; pileus dry; spores oblong or short-elliptical, about twice longer than broad.

LEUCOGYROPORUS—Stipe glabrous, solid; pileus dry, glabrous, felted, or subtomentose; spores narrowly-ellipsoid to more or less cylindric or subfusiform, 3 to 4 times longer than broad.

Subfamily **STROBILOMYCETAEAE**—Spores ornamented, reticulate, striate, or verrucose.

STROBILOMYCES—Spores reticulate, globose; pileus squarrose-scaly; tubes not boletinoid; separable from the carpophore with difficulty and not at all from each other.

BOLETELLUS—Spores longitudinally striate or wrinkled, or verrucose, elliptical, large.

POLYPORELETUS—Spores verrucose, spherical.

TENTATIVE KEY TO BOLETACEAE OF THE THUJA-TSUGA ZONE ON THE
KANIKSU NATIONAL FOREST⁴

1. Color of flesh of pileus or stipe, or both, changing to blue when cut or broken. 2
Color of flesh of pileus or stipe, or both, changing to some other color when cut or broken, or not changing. 12
2. Margin of pileus tomentose when young, usually loosely and densely so, the tomentum disappearing before pileus is half expanded, color yellow, with or without red brown or vermilion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, almost always hollow at base in this region, densely glandular-dotted, the glandules greenish brown, conspicuous, frequently confluent. 12. *Suillus americanus*
Margin of pileus never tomentose. 3
3. Pileus some shade of bright yellow or orange, glabrous or fibrillose-scaly; tube surface dull or dirty yellow, changing to blue on injury; stipe various shades of yellow, masked by glandular-dots which are pale when young, brown when mature, annulus none.
. 5. *Suillus hirtellus* var. *mutans*
Pileus some shade of gray, olive, brown, or rose, not yellow or orange. 4

⁴ This key is designed only for use with the 23 species described in this article. Specimens identified with the aid of this key should be carefully compared with the detailed descriptions, since generic distinctions are omitted as such and species not included may prove confusing.

4. Stipe dirty white, scabrous to squamulose, changes to greenish blue where bruised; pileus slightly reddish brown, dull orange, or yellowish orange, glabrous, viscid; tube surface dirty white. 22. *Leccinum versipelle*
Stipe neither white nor squamulose-scabrous. 5
5. Pileus viscid, particularly in wet weather, gray brown to gray, sometimes with irregular patches of red brown or blue, or both; tube surface sand brown to brownish gray, usually changing to blue where bruised; stipe dirty white to faintly brownish gray, reticulate at apex, rarely almost to middle of stipe, annulus small, usually disappearing. . 6. *Suillus aeruginascens*
Pileus not viscid, at most somewhat moist. 6
6. Flesh of pileus with bitter taste, pileus olive brown; stipe lemon yellow, conspicuously reticulate almost to base in our collection, but usually regarded as not reticulate or only slightly so. 19. *Boletus fragrans*
Flesh of pileus without bitter taste, although some may be unpleasant. 7
7. Stipe some shade of red, at least in part. 8
Stipe yellow or brown, not red. 11
8. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow; pileus dark greenish brown, stipe deep crimson to brownish red; flesh of stipe and pileus changing to blue slowly, usually from 10 to 30 minutes following cutting; apparently occurring only in western redcedar—western hemlock associations. 13. *Xerocomus Zelleri*
Tube surface turning blue where bruised. 9
9. Stipe uniformly red at base, yellow at apex; pileus olivaceous khaki, rimose-areolate over whole surface, the cracks sometimes reddish. 16. *Xerocomus* sp.
Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown. 10
10. Pileus rose, beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow. 17. *Xerocomus* sp.
Pileus warm brownish khaki to dull brown, with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract, at least in part; stipe pinkish brown, or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; a large species. 14. *Xerocomus subtomentosus*
11. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract. 15. *Xerocomus ? pulverulentus*
Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract, at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; a large species. 14. *Xerocomus subtomentosus*
12. Tubes boletinoid (arranged more or less in rows radiating outward from stipe) in all specimens. 13
Tubes not boletinoid, or at least not so in all specimens. 15
13. Stipe hollow, yellow from decurrent tube surface above annulus, brown below; pileus mahogany or chocolate brown, or rarely golden yellow, fibrillose-scaly; common in western larch—western white pine associations. 1. *Boletinus cavipes*
Stipe solid. 14
14. Pileus some shade of red or pink, with yellowish cast present in varying degree, coarsely fibrillose-scaly; tube surface mustard to dull olivaceous yellow, decurrent on stipe forming reticulation almost to base; common in western larch—western white pine associations. 3. *Boletinus ochraceoseus*
Pileus light brownish yellow, glabrous to faintly fibrillose, stipe dull yellow, no annulus. 4. *Boletinus ? appendiculatus*
15. Pileus deeply cracked (rimose-diffract), buff to sand brown, closely canescent; tubes short, mouths extremely small, being rarely larger than 0.15 mm.; stipe buff to sand brown, reticulation on top half only. 21. *Boletus frustulosus*
Pileus not deeply cracked. 16
16. Stipe brownish red to dull crimson, bulbous to subbulbous, tapering strongly upward, reticulate near apex; pileus dark chocolate brown, tomentose to fibrillose-scaly, the scales often in the form of conic points or projections about the center; tube surface bright lemon yellow

- to dull mustard yellow; common only in western redcedar—western hemlock associations... 20. *Boletus mirabilis*
- Stipe some shade of white, gray, yellow, or brown; not red..... 17
17. Stipe reticulate almost full length, light yellowish brown, no annulus; pileus khaki, glabrous; tube surface white at first, then greenish white..... 18. *Boletus edulis*
- Stipe not reticulate almost full length, although some may be reticulate near apex..... 18
18. Stipe scabrous, rough, dirty white with projections gray or brown; pileus glabrous, color variable in shades of brown; tube surface dull white to fawn..... 23. *Leccinum scabrum*
- Stipe not scabrous..... 19
19. Stipe hollow at maturity, unusually slender and tough, densely glandular-dotted, the glandules greenish brown; pileus golden to mustard yellow, with or without brownish red or vermilion patches or streaks; flesh of stipe and pileus changing to faintly roseate when cut, or very rarely to faint blue at base of stipe only..... 12. *Suillus americanus*
- Stipe not hollow..... 20
20. Annulus usually appressed-cylindric, wide, persistent, of the same color and surface texture as the pileus, varying from bronze through olive drab to a dirty buckskin yellow; stipe yellow at apex, white to base, masked by the dense greenish brown glandular-dots; pileus glabrous, but appearing conspicuously fibrillose (fibrillose-virgate), viscid only when wet; tube surface lemon to dull mustard yellow, the mouths flecked with brownish glandules..... 10. *Suillus subluteus*
- Annulus none, or if present not appressed-cylindric..... 21
21. Annulus none at any stage of development..... 22
- Annulus present at least when immature..... 24
22. Margin of pileus never tomentose, rarely fibrillose-appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular-dotted usually less than half the length..... 9. *Suillus granulatus*
- Margin of pileus tomentose when young, before halfway expanded..... 23
23. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish brown and frequently confluent, conspicuous; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten..... 12. *Suillus americanus*
- Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *S. americanus*, rarely may be marked with red brown or vermilion streaks or patches; readily confused with *S. granulatus* or *S. americanus*..... 8. *Suillus* ? *subaureus*
24. Pileus gray or gray brown, viscid, particularly in wet weather; stipe dirty white to faintly brownish gray, may change to blue where bruised; flesh of stipe and pileus also commonly changes to blue where cut or broken, but some specimens show no change, these chiefly immature; flesh soft, frequently watery..... 6. *Suillus aeruginascens*
- Pileus yellow to brown, not gray or gray brown..... 25
25. Pileus dry, not viscid, coarsely fibrillose to fibrillose-scaly, cocoa brown; stipe yellow from decurrent tube surface to annulus, brown, like the pileus, below; common only in association with Douglas fir, in this region..... 2. *Boletinus amabilis*
- Pileus not dry, usually viscid..... 26
26. Stipe not glandular-dotted, usually brown-fibrillose over golden yellow; annulus prominent, persistent, but not flat and wide; pileus bright, shiny golden brown or chestnut, viscid; tube surface bright golden yellow; common in western larch—western white pine associations..... 7. *Suillus elegans*
- Stipe glandular-dotted..... 27
27. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted; annulus absent in approximately half specimens collected, but when present tomentose, not flaring, usually fragmentary; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten..... 12. *Suillus americanus*
- Stipe stout, not particularly tough, glandular-dotted, especially above the annulus; annulus prominent, glutinous, flaring upward at least when young and usually to maturity; pileus dark buckskin or yellowish brown to reddish brown, thickly sticky-viscid..... 11. *Suillus luteus*

TEXT KEY AND SPECIES DESCRIPTIONS

A. Tubes boletinoid
(except sometimes in *Boletinus amabilis*.)

BOLETINUS Kalchbrenner

Tubes arranged radially in rows, usually with more or less prominent veins between, at least when young; tubes not easily separable from the carpophore and not at all from each other.

1. Stipe annulate, even when mature.....2
Stipe exannulate, at least at maturity.....3
2. Stipe hollow.....1. *Bol. cavipes*
Stipe solid; tubes in many specimens *not* boletinoid.....2. *Bol. amabilis*
3. Pileus some shade of red or pink, usually with yellowish cast, fibrillose-scaly.....3. *Bol. ochraceoroseus*
Pileus light brownish yellow, glabrous to faintly fibrillose.....4. *Bol. ? appendiculatus*

1. BOLETINUS CAVIPES (Opatowski) Kalchbrenner

Plate 1, fig. A; and Plate 7, fig. A.

SELECTED ICONES.—Kallenbach (1926-37, pls. 27, 33); Migula (1925, pl. 42B); Macku (1925, fig. 286); Farlow (1929, pl. 92); Michael-Schulz (1927, pl. 268); Konrad and Maublanc (1924-37, pl. 420); Juillard-Hartmann (1919 et seq., 4: 196 (4)).

HABIT.—Gregarious, rarely caespitose. PILEUS—*Shape*: broadly convex, usually subumbonate. *Margin*: sometimes partly fibrillose-appendiculate when young. *Diameter*: 6-25 cm., usually 8-15 cm. *Surface*: soft, fibrillose-squamulose to squamose, rarely somewhat rimose in old specimens; color mahogany (8L6) to a reddish chocolate brown (8L8), or tawny brown, rarely a dull golden yellow (11K6). *Flesh*: firm, sometimes somewhat soft; color lemon to pale yellow, deeper near tubes; taste farinaceous to slightly bitter; odor faintly acrid, or not distinctive. *Tubes*: decurrent, short, strongly sublamellate, radiating; color bright sulphur yellow (10K1) when young to chartreuse yellow (11L1), or dingy ochraceous in age; mouths compound, angular, 0.5-3 mm. diameter. *Veil*: white, evanescent, partly adhering to the margin of the pileus and partly to the stipe. STIPE—*Shape*: tapering upward, subbulbous, or even subequal. *Annulus*: delicate, conspicuous, white at first, then ochraceous. *Reticulation*: more or less, tube dissepiments usually decurrent to the annulus. *Surface*: fibrillose-scaly below annulus, or floccose, dry; color brown or tawny, like top of pileus, below annulus; yellow, like tubes, above. *Interior*: hollow, the cavity large, occupying most of the base of the stipe at maturity, sometimes stuffed when young; color yellow about the cavity, pale brown to pinkish brown zone beneath cortex. *Length*: 4-10 cm. *Diameter*: 1.5-4.5 cm. at point of maximum diameter. SPORES—*Color in mass*: olivaceous-

ochraceous when fresh, changing later to yellowish-ochraceous. *Shape*: ellipsoid. *Color under microscope*: pale yellowish, the membrane somewhat bright. *Dimensions*: $7.5-10 \times 3-4\mu$, few $14-18 \times 5-6\mu$, mostly $8-10 \times 3.5\mu$. CYSTIDIA—Rare. *Shape*: clavate, or fusiform, occasionally truncate at apex. *Color under microscope*: hyaline. *Dimensions*: $58-85 \times 6-8\mu$.

Four collections (UIFP 1972, 2584, 3276, 3640) of a golden yellow form of this species were made in the course of the study. In every respect except color, these specimens conformed to the description of *Bol. cavipes*. Perhaps these should be referred to the variety *aurea* Rolland, but since golden specimens have been found intermixed with the more common brown forms, there seems little justification for use of this varietal distinction.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: wet specimens dry with extreme shrinkage, frequently losing 75% of the original volume. Best results are obtained with collections made during dry weather, or at least when there has been no rain for several days, for much water is taken up by this species. Edges often curl badly, and the fibrillose texture of stipes and pilei is often lost. Features of the tube surfaces are often well preserved, and, since immature specimens shrink less, the veil and annulus are usually preserved. *Color of pileus*: light coffee brown (15A11), the golden form dull golden yellow (11L5 to 11L6) in young specimens; ochraceous yellow, the scales brown, in mature forms; to warm brown, or dull cinnamon brown (14G11) in old, wet specimens. *Color of tube surface*: suntan khaki (13L7) in young specimens, to a cinnamon brown (14J10), or lighter, in mature ones, or even raw sienna (13L10). *Color of stipe*: same as pileus.

DISTINGUISHING CHARACTERISTICS.—The only known species of *Boletinus* with a hollow stipe. The hollow is clearly seen in Plate 1, fig. A. Here, as in *Bol. amabilis*, the stipe is divided into two color zones by the annulus, the upper yellow like the tubes, the lower brown or golden, like the pileus. These two species are grossly different in appearance, *Bol. cavipes* being broader, much darker brown characteristically, and loosely fibrillose-squamulose.

HABITAT NOTES.—This species occurs generally in consociations dominated by *Pinus monticola* and *Larix*, and is common in the region. All collections recorded were made in the 61–80 year age class, but specimens were observed in stands as young as 21–40 years. It has not been observed in older age classes, perhaps because these classes are relatively rare in the more accessible parts of the area studied. In other regions the species has been reported commonly associated with *Larix* species, and *L. occidentalis* was present in all associations in which collections were made, although in some instances *P. monticola* appeared to be most closely associated. It has not been observed in the spring, all collections being made

between mid-September and late October. It frequently occurs on roadside banks, but is at least equally common on the forest floor away from roads and trails.

MYCORRHIZAE.—Reported on *Larix decidua* in Italy (Peyronel, 1922).

EDIBILITY.—Kallenbach (1926-37) states that it is edible and savory.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3276 (Wash.), 1972, 2563, 2576, 2584, 3237, 3640, 3657 (Idaho).

2. *Boletinus amabilis* (Peck) Snell, comb. nov.

Boletus amabilis Peck

Plate 1, fig. B; and Plate 7, fig. B.

SELECTED ICONES.—None known.

HABIT.—Usually solitary, sometimes gregarious. PILEUS—*Shape*: convex. *Margin*: somewhat appendiculate with veil remnants at least when young, sterile in places. *Diameter*: 3-17 cm., usually 3-10 cm. *Surface*: fibrillose to fibrillose-scaly, moist only under conditions of high humidity, never viscid in this region; general color effect cocoa brown, a combination of brown fibrils over a yellowish brown cuticle; cannot be accurately described by reference to a single color. *Flesh*: firm; color variable, a pale old ivory (10G3), lemon yellow (10K3), or yellowish buckskin (11K4), the latter in older specimens, darkening to brown after several minutes when cut; taste and odor mild, not distinctive. *Tubes*: adnate to subdecurrent, the latter rarely; separable; color light sulphur yellow (9K1) when young, dandelion yellow (9L4) at maturity, light ochre (11L6) when old, turning brown where bruised; mouths glandular-dotted, angular, radially elongate, more or less completely radiately arranged (boletinoid) and sublamellate, in many specimens at least halfway to the margin, but in many others not at all boletinoid, over half our specimens the latter form, 0.5-1.5 mm. diameter. *Veil*: thin, fibrillose, white, ivory, or brownish, fibrillose patches adhering to the stipe below annulus, fragments adhering to margin of pileus when young. STIPE—*Shape*: subequal, or tapering upward. *Annulus*: near apex, straw-colored, whitish when young, fibrillose-scaly, narrow, usually poorly defined at maturity. *Reticulation*: none, or slightly reticulate with tube dissepiments decurrent almost to annulus in rare specimens. *Surface*: glabrous, or sometimes sparsely glandular-dotted above annulus, fibrillose to fibrillose-scaly, patches of veil adhering below annulus; color above annulus yellow like tubes, below, cocoa brown, or reddish brown, like pileus, the annulus usually sharply dividing the two color zones. *Interior*: solid; color pale lemon yellow (10J2) to brilliant lemon yellow (10K3), darkening to reddish brown after some time. *Length*: 4-9 cm. *Diameter*: 1-2.5 cm. SPORES—*Color in mass*: coffee brown. *Shape*: elliptical. *Color under microscope*: hyaline, to pale olivaceous, a few deep olivaceous. *Dimensions*: 8-11 × 3-4μ, mostly 9 × 3.5μ. CYSTIDIA—Rather common,

clustered, two forms. *Shape*: cylindrical-clavate, or fusiform. *Color under microscope*: hyaline. *Dimensions*: $50-60 \times 4-5\mu$. *Shape*: cylindrical-clavate. *Color under microscope*: brown. *Dimensions*: $50-55 \times 6-7\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: often severe, some specimens shrinking 75% in volume. The fibrillose texture of the pilei, and the sublamellate, boletinoid, arrangement of the tubes, where present, are preserved. The annulus is also clearly visible in most specimens. Color of the pileus is somewhat lighter than when fresh, but the tube surfaces turn brown. *Color of pileus*: grayish brown (14E7) to light cinnamon brown (14I9), the fibrils dark brown. *Color of tube surface*: bronze brown (14K9) to cocoa brown (15C11). *Color of stipe*: brown, somewhat lighter than the pilei.

DISTINGUISHING CHARACTERISTICS.—This species cannot be confused with any other described here. The cocoa brown, coarsely fibrillose, or fibrillose-scaly pileus, and the stipe divided into two color zones by the annulus, the upper zone yellow, like the tubes, the lower zone brown, like the surface of the pileus, characterize this species without fail. Both these characteristics are visible in Plate 1, fig. B. No other species collected shows such closely appressed, loosely interwoven, coarse, brown fibrils, through which the yellowish brown cuticle appears. Its association with *Pseudotsuga* is also diagnostic, at least in this region.

HABITAT NOTES.—*Bol. amabilis* is the only species collected which appears commonly in both the *Thuja-tsuga* and *Pseudotsuga* zones in the region. It is the only bolete found to date in the latter zone, and appears in all associations of the former in which *Pseudotsuga* occurs. There is no doubt that *Pseudotsuga* is the typical associate, since this bolete occurs commonly in pure stands of that species. Collections have been made both spring and fall, the best development occurring from two weeks to a month following the beginning of fall rains, in a normal season. Although frequently found along roadsides, specimens occur with approximately equal frequency under the forest canopy.

MYCORRHIZAE.—No record found, although its constant association with *Pseudotsuga* suggests such a relationship.

EDIBILITY.—Apparently not demonstrated.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1539, 2577, 2589, 3045, 3241 (Idaho).

3. BOLETINUS OCHRACEOROSEUS Snell

Plate 1, fig. C; and Plate 7, fig. C.

SELECTED ICONES.—None published.

HABIT.—Gregarious. PILEUS—*Shape*: convex, center usually depressed. *Margin*: appendiculate with fragments of veil when young only. *Diameter*: 6-20 cm. *Surface*: dry, coarsely fibrillose-squamulose, fibrillose-scaly, to

almost squamose, soft to the touch; color variable, from rose pink (1E8), to brick red (5K10), the roseate color somewhat masked by an over-all ochre yellow cast which varies in its conspicuousness; generally darker in dry seasons, paler in seasons with prolonged wet, sunless periods. *Flesh*: firm; color pale ochre yellow, unchanging; taste mild, not distinctive; odor somewhat resinous. *Tubes*: decurrent, short, inseparable; color a bright mustard yellow (11L2) to dull olivaceous yellow (12L2), the walls somewhat glandular-dotted, but rarely visibly so under a hand lens; mouths radiately arranged and sublamellate, much as in *Boletinellus meruloides*, but less prominently so, compound, 0.5–3 mm. diameter. *Veil*: delicately membranous, white to buff. *STIPE*—*Shape*: tapering up to subbulbous. *Annulus*: evanescent, at first prominent, then consisting of fibrillose fragments, then disappearing, some specimens having no annulus at any stage of development. *Reticulation*: rotund- or venose-reticulate, usually above annulus, but sometimes below, particularly when stipe is short. *Surface*: glabrescent, or pilose-velutinous to fibrillose-squamulose in places, the latter rarely; color ochre yellow, the reticulations brownish, sometimes rose at base. *Interior*: solid; color ochre yellow, unchanging. *Length*: 2–4 cm. *Diameter*: 1.5–2.5 cm. *SPORES*—*Color in mass*: deep red brown, the red most evident when fresh, later changing to cocoa brown. *Shape*: narrowly-elliptical. *Color under microscope*: pale greenish yellow. *Dimensions*: $8-10 \times 2.8-3.5 \mu$, mostly $9 \times 3 + \mu$. *CYSTIDIA*—Two forms, clustered and single. Clustered, especially at the mouths. *Shape*: clavate. *Color under microscope*: hyaline. *Dimensions*: $30-35 \times 5-6 \mu$. Single on the tube walls. *Shape*: clavate, to irregularly ventricose-rostrate, or hyphoid. *Color under microscope*: hyaline. *Dimensions*: $50-55 \times 5-7 \mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: shrinks only moderately, the texture and appearance being unusually well preserved in most specimens. Stipe reticulation is lost in all but rare specimens and traces of the annulus can be found only rarely. The reddish tints are little changed, but the ochraceous cast is usually lost. *Color of pileus*: a yellowish buff (10H4) to dull but definite red (5K3), or mixtures of lighter shades of red and darker buff browns. Rare specimens show some yellowish tinge. *Color of tube surface*: various shades of brown, from dull brownish khaki (14J7) to chocolate browns (8H10 to 8J11). *Color of stipe*: often same as tube surface, or dull golden yellow shades, sometimes red-tinted, the base usually with a covering of creamy mycelium.

DISTINGUISHING CHARACTERISTICS.—The only species of *Boletinus* found in the region with a red or pinkish pileus. Usually a striking species.

HABITAT NOTES.—This species appears in all associations of the *Thuja-Tsuga* zone which include *Larix*. There is little doubt that *Larix* is the typical associate. Throughout the region spring appearances of species of the Boletaceae are relatively rare, this being perhaps the outstanding ex-

ception. Certain areas regularly support fairly large numbers each spring, although, as in the other species, optimum development occurs during the fall, in late September and early October in a normal season.

MYCORRHIZAE.—Not demonstrated, but almost certainly a mycorrhizae-former with *Larix*, as indicated by its virtually constant association.

EDIBILITY.—Not demonstrated.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1641, 1971, 2427, 2428, 2565, 3046, 3085 (Idaho).

4. BOLETINUS ? APPENDICULATUS Peck

Plate 7, fig. D.

SELECTED ICONES.—None known.

HABIT.—Solitary. PILEUS—*Shape*: convex. *Margin*: appendiculate with a thick, incurved, conspicuous veil. *Diameter*: 10–20 cm. *Surface*: glabrous, faintly fibrillose when young; color light brownish yellow when young, later ochraceous yellow. *Flesh*: color pale yellow, unchanging; taste and odor not recorded. *Tubes*: decurrent; color dull yellow, becoming darker, or brownish, when wounded; mouths rather small, angular, unequal. *Veil*: thin, incurved, the remnants attached to margin of the pileus. STIPE—*Shape*: slightly thickened at base. *Annulus*: none. *Reticulation*: near apex only, from dissepiments of decurrent tubes. *Surface*: moist, glabrous; color yellow. *Interior*: characters not noted. *Length*: 5–7 cm. *Diameter*: 0.8–1.2 cm. SPORES—*Color in mass*: not recorded. *Shape*: oblong-ellipsoid. *Color under microscope*: pale yellow. *Dimensions*: 10–12 × 4 μ (Peck's measurements). CYSTIDIA—Characters not noted.

REMARKS.—This collection agrees closely with Peck's description of *Bol. appendiculatus*, with the exception of spore dimensions, those of this specimen being somewhat smaller. However, since the specimen was obviously immature when collected, there is little doubt concerning its identity.

CHARACTERISTICS OF DRIED SPECIMENS.—The senior author's single, very small specimen offers insufficient material for accurate description.

DISTINGUISHING CHARACTERISTICS.—The glabrous, or only slightly fibrillose, surface of the pileus serves to distinguish this species from others of the genus described here, the remainder being conspicuously fibrillose, or more or less coarsely fibrillose-scaly. In color it can be confused only with the golden form of *Bol. cavipes*, which differs in having a hollow stipe and a coarsely fibrillose, or fibrillose-scaly pileus.

HABITAT NOTES.—The single collection of this species was found in a

PLATE 1. Figure A. *Boletinus cavipes* (Opatowski) Kalchbrenner, UIFP⁵ 2563. B. *Boletinus amabilis* (Peck) Snell, UIFP 3045. C. *Boletinus ochraceoroseus* Snell, UIFP 3046.

⁵ University of Idaho Forest Pathology Herbarium number.



PLATE I. (See opposite page for explanation.)

consociation dominated by *Larix*. Trees in proximity were *Larix* and *Pinus monticola*. The specimen was collected in late June, and, although the area has been revisited many times, no additional specimens have been seen.

MYCORRHIZAE.—No record found.

EDIBILITY.—Apparently the species has not been tested.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3086 (Idaho).

B. Tubes not boletinoid.

I. Stipe not reticulate, except at very apex or above annulus in a few forms; not scabrous.

a. Pileus viscid when wet, or at all times, at least in some degree; tubes adnate or decurrent, not free, and not stuffed when young; spores elliptical.

SUILLUS *Micheli* ex S. F. Gray

Pileus viscid or glutinous, at least when wet; tubes compound, not radiately arranged or separated by lamellae, adnate or decurrent, not stuffed when young; stipe not reticulate, except at very apex or above annulus in a few forms, annulate or exannulate; spores narrowly elliptical.

1. Color of flesh of pileus or stipe, or both, changes to blue when cut or broken. 2
 Color of flesh of pileus or stipe not changing to blue, although a change to brown may occur in some species. 4
2. Pileus yellow or orange, with or without streaks or patches of red brown or vermillion. 3
 Pileus gray or gray brown, soft; tubes sand brown or brownish gray. 6. *S. aeruginascens*
3. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, very rarely changing to blue at base of stipe when cut or broken, densely glandular-dotted, glandules greenish brown and frequently confluent; pileus may be streaked red brown or vermillion, stains hands yellow with sticky-viscid gluten. 12. *S. americanus*
 Stipe neither slender nor particularly tough, never hollow, glandular-dotted, the glandules small, brown but not greenish-brown; pileus without reddish markings, color bright yellow or orange, does not stain hands yellow; flesh changes to clear blue when cut or broken. 5. *S. hirtellus* var. *mutans*
4. Stipe not glandular-dotted. 5
 Stipe glandular-dotted. 6
5. Pileus gray brown, glabrous, soft; tubes sand brown to brownish gray, usually changing to blue where bruised, but some specimens show no change. 6. *S. aeruginascens*
 Pileus shiny golden brown or chestnut; tubes bright golden yellow. 7. *S. elegans*
6. Annulus present, at least in a few specimens. 7
 Annulus not present at any stage of development. 9
7. Margin of pileus never tomentose at any stage of development. 8
 Margin of pileus tomentose when immature, usually loosely and densely so, the tomentum disappearing before pileus is fully expanded, color yellow, with or without red-brown or vermillion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, densely glandular-dotted, glandules greenish-brown, conspicuous, frequently confluent. 12. *S. americanus*
8. Veil not sheathing the whole stipe, entirely superior; annulus usually wide, appressed-cylindric, of same color and texture as pileus, fibrillose-virgate, viscid when wet; pileus broadly subconic to convex, typically the former; stipe densely glandular-dotted, glandules confluent

- into large greenish-brown patches toward base. 10. *S. subluteus*
 Veil sheathing the stipe; annulus usually flaring upward, not appressed-cylindric, viscid when wet, often disappearing at maturity; pileus relatively thick, rounded pulvinate approaching hemispherical; stipe glandular-dotted, especially above the annulus. 11. *S. luteus*
9. Margin of pileus tomentose when young. 10
 Margin of pileus never tomentose, rarely fibrillose-appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular-dotted usually less than half the length. 9. *S. granulatus*
10. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish-brown and frequently confluent; pileus yellow, may be streaked red brown or vermilion, stains hands yellow with sticky-viscid gluten. 12. *S. americanus*
 Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *S. americanus*, rarely may be red brown or vermilion streaked, readily confused with *S. americanus* and *S. granulatus*. 8. *S. ? subaureus*

5. *Suillus hirtellus* (Peck) Snell, comb. nov.

var. *mutans* Peck *apud* Snell

Boletus hirtellus Peck var. *mutans* Peck *apud* Snell in *Mycologia* 33: 26. 1941.⁶

Boletus tomentosus Kauffman

Plate 2, fig. A; and Plate 7, fig. E.

SELECTED ICONES.—None known.

HABIT.—Gregarious, rarely caespitose. PILEUS—*Shape*: convex, commonly hemispheric, rarely slightly subumbonate. *Diameter*: 4–12 cm. *Surface*: texture extremely variable, even among individuals of the same collection, some glabrous, others fibrillose, fibrillose-scaly, as in Plate 2, fig. A, squamulose, or rarely rimulose; moist, somewhat viscid in wet weather, rarely completely dry; color golden yellow (10L7) when young to various shades of yellow when mature, from light sulphur yellow (9K1) to yellowish cream (9H2). *Flesh*: firm, rarely soft in old specimens; color light sulphur yellow (9K1), sometimes paler, changing to blue almost immediately following cutting or breaking; taste mild, not distinctive; odor slightly acid. *Tubes*: adnate, adnate-depressed, adnexed, rarely almost free, or even slightly subdecurrent; color dull or dirty olivaceous golden yellow (12L6), changing to blue where bruised; walls glandular-dotted; mouths angular, often radially subelongate, glandular-dotted, 0.5–1.5 mm. diameter. STIPE—*Shape*: tapering upward, often subequal, or even subbulbous. *Annulus*: none. *Reticulation*: none. *Surface*: glandular-dotted entire length, sometimes tomentose, or fibrillose-squamulose toward base, often white-mycelioid at base, usually dry; color various shades of yellow, usually masked by the brownish glandular-dots, darkening with age as the color of the glandules deepens, frequently changing to blue

⁶ Peck never published a description of his variety *mutans*. The name appears on a specimen from Idaho in Peck's herbarium and also in his notebook Vol. 26, pp. 14 and 40, with a brief description.

where bruised. *Interior*: solid; color light sulphur yellow (9K1), or sometimes paler, if the latter, then deeper yellow under the pellicle, changing to blue shortly following cutting. *Length*: 3–10 cm. *Diameter*: 1–3 cm. SPORES—*Color in mass*: olive brown. *Shape*: elliptical, or slightly subfusiform. *Color under microscope*: pale yellowish-greenish to pale olivaceous. *Dimensions*: $7-11 \times 2.5-3.5\mu$, mostly $8-9 \times 3$ or $3+\mu$. CYSTIDIA—Generally two forms, in glandular-dots on tubes and stipe, and scattered in the hymenium. In glandular-dots, *shape*: clavate to ventricose-rostrate, some irregularly curved, knobbed, or gnarled. *Color under microscope*: hyaline, to deep yellow brown. Scattered in the hymenium, *shape*: clavate to short ventricose-rostrate. *Color under microscope*: hyaline to deep brown. *Dimensions*: $35-60 \times 8-15\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: Specimens shrink as much as 75% in volume, but distortion is only moderate, texture of the pilei is usually well preserved, stipe glandules are usually plainly visible without a hand lens. Colors are generally much degraded, but young specimens frequently remain somewhat brighter than older ones. *Color of pileus*: light ochre yellow (11L6), chamois (11J5), light brownish khaki (13K7), or rarely as dark as light burnt umber (15C12). *Color of tube surface*: bronze (14L9) to dark olive brown (15L9), the tube mouths blackish in the latter. *Color of stipe*: light suntan khaki (13J7), deep olivaceous gray (15E5), or medium gray (14H4), often with a bluish, or greenish cast in the gray colors; the glandules usually prominent, black.

DISTINGUISHING CHARACTERISTICS.—Its bright yellow color, and almost immediate change to blue when cut or bruised make it impossible to confuse this species with others collected in the region.

HABITAT NOTES.—This is one of the most common species of boletes found in seral associations in the *Thuja-Tsuga* zone, only a single collection being found in climax *Thuja-Tsuga*. It has not been observed in either the *Pseudotsuga* or *Pinus ponderosa* zones in the region. Apparently there is no consistent association with one or two tree species. Fruiting bodies appear both spring and fall, but are comparatively rare in spring. They usually appear in largest numbers between September 15 and October 31, optimum development occurring from two weeks to a month after fall rains begin. They develop in humus and mineral soil, and are more common under the forest canopy than along roadside banks and trails. The largest concentrations have been found in improved campsites where some thinning has been done, and in areas where small logging operations were carried on a few years earlier.

MYCORRHIZAE.—No reports found.

EDIBILITY.—Apparently has not been tested.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1540, 1541, 2571, 2603, 2618, 2621, 3044, 3226, 3238, 3252, 3639 (Idaho).

6. *Suillus aeruginascens* (Secretan) Snell, comb. nov.*Boletus viscidus* L. ex Fries

Plate 2, fig. B; and Plate 7, fig. F.

SELECTED ICONES.—Kallenbach (1926-37, pls. 18, 25); Konrad and Maublanc (1924-37, pl. 416); Jaccottet (1925, pl. 59); Michael-Schulz (1927, pl. 269).

HABIT.—Gregarious, sometimes caespitose. PILEUS—*Shape*: at first globose, then pulvinate, occasionally subumbonate, rarely plane. *Margin*: fibrillose-appendiculate when young only. *Diameter*: 4-13 cm. *Surface*: viscid when wet, variously fibrillose-tomentose, fibrillose-squamulose, innately fibrillose, or entirely glabrous, the latter form most common in this region, characters of the surface frequently varying with the weather; color shiny drab brown when young, later gray, smoke gray, or gray brown (varying from 36A1 or 36A2 to 6A8) at maturity, sometimes with irregular roseate to red brown areas, or indefinite bluish patches, or both colors appearing on the same individual; in other regions varying from dark reddish brown, through gray tints, to almost entirely white, becoming paler and more glabrous in wet weather. *Flesh*: firm when young, soft at maturity; color white to pale yellowish white, often hygrophanous, changing to blue when cut, rare individuals show no color change, the latter usually immature; taste somewhat fruity, or mild and not distinctive; odor none, or faintly resinous. *Tubes*: adnate, rarely subdecurrent; color light sand brown (12B3) when young to light smoke gray (5A8) at maturity, usually changing to blue where bruised, or at least turning darker; mouths irregular, angular, rather large, sometimes more or less radiately arranged and somewhat lamellate-compound (see Plate 2, fig. B), 0.5-1.5 mm. diameter. STIPE—*Shape*: subequal, to tapering upward. *Annulus*: small, near apex, tangled-fibrous to floccose-membranous, perhaps sheathing to base, grayish, but occasionally colored brown by the spores, usually disappearing early, but occasionally persisting to maturity. *Reticulation*: usually reticulate above annulus from dissepiments of decurrent tubes, in rare specimens extending downward almost to middle of stipe, but rather faint at this point. *Surface*: somewhat viscid when wet, usually slightly pitted, lacerate-fibrous, or fibrillose-scaly; color dirty white to light smoke gray (5A8), sometimes changing to greenish blue in limited areas where bruised; has been reported from other regions variously with yellowish tints and clothed with reddish brown, or brownish red. *Interior*: solid, fibrous; color white, yellowish toward base, changing to bluish or greenish chiefly at base when cut. *Length*: 3-11 cm. *Diameter*: 0.8-2 cm. SPORES—*Color in mass*: more or less faded, grayish brown, to almost ferruginous-brownish, or chocolate brown. *Shape*: elliptical to subfusiform. *Color under microscope*: pale olivaceous. *Dimensions*: 8-14 × 3.5-5 μ, rarely to 17 × 6 μ,

mostly $10-13 \times 3.5-4\mu$. CYSTIDIA—Abundant on mouths, less so on walls, clustered or single. *Shape*: saccate-clavate to ventricose-rostrate, some strangulated, often encrusted. *Color under microscope*: hyaline, yellow, or brown. *Dimensions*: $40-80 \times 5-11\mu$. BASIDIA—Clavate to subclavate, $25-28 \times 7-9\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: Because of its initially high water content, this species dries very badly, losing from 75% to 90% in volume. The surface frequently wrinkles extensively, obscuring the original texture. If dried on a smooth surface, such as waxed paper, with tubes uppermost, this wrinkling is minimized when the specimens are badly watersoaked, the fibrillose character of the pileus being moderately well preserved. Some old specimens dried in this manner, although losing little in diameter, shrink to about 2 mm. in thickness. In young specimens the veil is usually well preserved, and the annulus is also readily discernible. *Color of pileus*: grayish brown (14J6 to 14J8) to shades of umber brown (15A12 to 15H11), young specimens usually darker. *Color of tube surface*: dark browns (16A10 to 16A12). *Color of stipe*: light chamois (approximately 11G5) in very young specimens, a dull buff (approximately 12H6) to blackish brown in old, watersoaked specimens.

DISTINGUISHING CHARACTERISTICS.—The only viscid, gray bolete seen in the region in which the flesh changes to blue when cut or bruised.

HABITAT NOTES.—This species occurs in consociations dominated by *Larix occidentalis* and *Pinus monticola*. It has been observed in all age classes of the seral association in which *Larix* is present in appreciable numbers, except those in which this tree is represented only by widely scattered, overmature individuals, relics of a preceding stand. It is generally considered, with *S. elegans*, a laricophilous species, occurring in Europe, as well as North America, in association with that species under *Larix*. These two boletes are characteristically found together in the same consociations in this region. Fruiting bodies are seldom abundant, but are most common in the fall, from two weeks to a month after fall rains begin. Spring appearance is rare. Although found along roadside banks and trails, they are more common under the forest canopy.

MYCORRHIZAE.—Reported as the probable fungal component of mycorrhizae on *Larix decidua* in Britain (How, 1942) and Italy (Peyronel, 1920). Experimentally, this species has also formed mycorrhizae on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940).

EDIBILITY.—Reported edible by European authorities, but Kallenbach (1926-37) states that it is not worth recommending, since it is slimy and the flesh is usually soft and watersoaked.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2567, 2579, 2580, 2587, 2611, 3047, 3623 (Idaho).

7. *Suillus elegans* (Fries) Snell, comb. nov.*Boletus elegans* Fries*Boletus Clintonianus* Peck

Plate 2, fig. C; and Plate 7, fig. G.

SELECTED ICONES.—Kallenbach (1926-37, pls. 17, 25); Farlow (1929, pl. 72); Michael-Schulz (1927, pls. 84, 271); Bresadola (1931, pl. 902); Macku (1925, fig. 137); Migula (1925, pl. 42); Jaccottet (1925, pl. 59); Juillard-Hartmann (1919 et seq., 4: 185 (1)).

HABIT.—Gregarious, rarely caespitose. PILEUS—*Shape*: convex, often becoming plano-convex, occasionally depressed in the center, or subumbonate. *Margin*: occasionally appendiculate with veil remnants, especially in dry weather. *Diameter*: 4-15 cm., usually 5-10 cm. *Surface*: glabrous, viscid, usually with a heavy yellowish to reddish brown gluten which dries radially, virgate-spotted in other regions; color usually chestnut brown (7J12), sometimes with a faint grayish, metallic cast, or lighter golden chestnut brown, often with a narrow yellow margin; in other regions commonly much lighter, pale lemon yellow, golden yellow, reddish yellow, or rich chestnut brown as in our specimens; the paler yellows rare with us; note that many icones show the paler colors not characteristic of this region. *Flesh*: firm; color various shades of yellow, from the characteristic brilliant golden yellow (10L6) to deep lemon (10L2), occasionally with a hygrophanous, brownish cast in an indefinite layer beneath the cuticle in old specimens; taste mild, not distinctive; odor faintly resinous, somewhat resembling turpentine, or faintly acid. *Tubes*: adnexed, adnate, or even slightly subdecurrent, comparatively short; color bright golden yellow (10L6), rarely brownish yellow in old specimens, becoming lilaceous, or brownish, where bruised; mouths angular, in part compound, 0.5-1.5 mm., usually 0.5-0.75 mm. diameter. *Veil*: pale lemon to golden yellow, becoming paler as it stretches, perhaps extending to the base, withdrawing to form the annulus. STIPE—*Shape*: tapering upward, to subequal. *Annulus*: prominent, near apex, thick, dark yellow to reddish brown, sometimes none in dry weather. *Reticulation*: usually finely reticulate near apex, occasionally in patches below the annulus. *Surface*: texture below the annulus very variable, subpruinose to fibrillose, or tomentose-punctate, rarely rugose to faintly scabrous, or even glabrous; color extremely variable, an indistinctly fibrillose outer layer, commonly in shades of brown, or golden brown over bright golden yellow cuticle, the apex brilliant yellow, like the tubes. *Interior*: solid; bright golden yellow to lemon yellow, becoming dingy brownish yellow. *Length*: 4-12 cm. *Diameter*: 1-2.5 cm. SPORES—*Color in mass*: golden brown to chestnut brown, drying ochraceous brown. *Shape*: elliptical to somewhat elliptic-fusiform. *Color under micro-*

scope: pale yellowish olivaceous. *Dimensions*: $7-11 \times 3-4\mu$, mostly $9 \times 3.5\mu$. CYSTIDIA—Numerous on tubes, mostly clustered. *Shape*: saccate-clavate to somewhat acuminate, many constricted, or capitate. *Color under microscope*: hyaline to yellow, or golden brown. *Dimensions*: $25-75 \times 4-10\mu$. MYCELIUM—White to yellowish.

The rich reddish, chestnut brown form of this species has been known as *Boletus Clintonianus* Peck. The yellow form, typical *Suillus elegans*, is rare in this region.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: severe, the surface of the pilei wrinkling badly. The annulus usually remains clearly discernible. Colors become seriously degraded, particularly the brilliant yellow of tubes and stipes. *Color of pileus*: brown, with a tan cast (7C12), bay (7E11) to dull blackish brown (8E3); a few individuals dry somewhat glossy, but the majority become dull. *Color of tube surface*: dull golden tan (13L8) to a cocoa brown (15E11) with a faint golden cast. *Color of stipe*: olivaceous golden yellow (12L6), honey-colored (12J6) to bay (7E11), or almost cocoa brown. In over 50% of dried specimens the stipes are brown, showing no indication of the original yellow color.

DISTINGUISHING CHARACTERISTICS.—The shiny, viscid, rich chestnut brown pileus, brilliant golden yellow tube surface, and annulate stipe of this common species distinguish it from all other forms in the region. It is possible that rare specimens of *S. luteus* might be confused with this species, but the glandular-dotted stipe of *S. luteus* should remove all doubt concerning its identity. That confusion may sometimes occur between these two species is borne out rather well by a plate of photographs by Güssow and Odell (1927, pl. 94), illustrating *Suillus luteus* (*Boletus luteus*). The specimens shown here are almost identical in appearance with our *S. elegans*, with the possible exception of two in the upper row in which the annulus is somewhat larger than most of ours. There is, however, a wide variation in the size and shape of the annulus in this, and other, species, and it is to be anticipated that typical specimens of *S. elegans* will be collected in which the annulus is fully as large, and similar in shape to those illustrated by Güssow and Odell.

HABITAT NOTES.—This is the commonest bolete species in consociations dominated by *Larix* and *Pinus monticola*. Its association with *Larix* species is generally accepted throughout the range of the genus, Melin (1922) suggesting obligate parasitism. *Larix* is also its most frequent associate in this region. Although it has been collected in every month between June and November, the optimum season is in early fall in a normal year, some specimens appearing until the onset of winter weather.

PLATE 2. Figure A. *Suillus hirtellus* (Peck) Snell var. *mutans* Peck *apud* Snell, UIFP 2603. B. *Suillus aeruginascens* (Secretan) Snell, UIFP 2567. C. *Suillus elegans* (Fries) Snell, UIFP 2566.

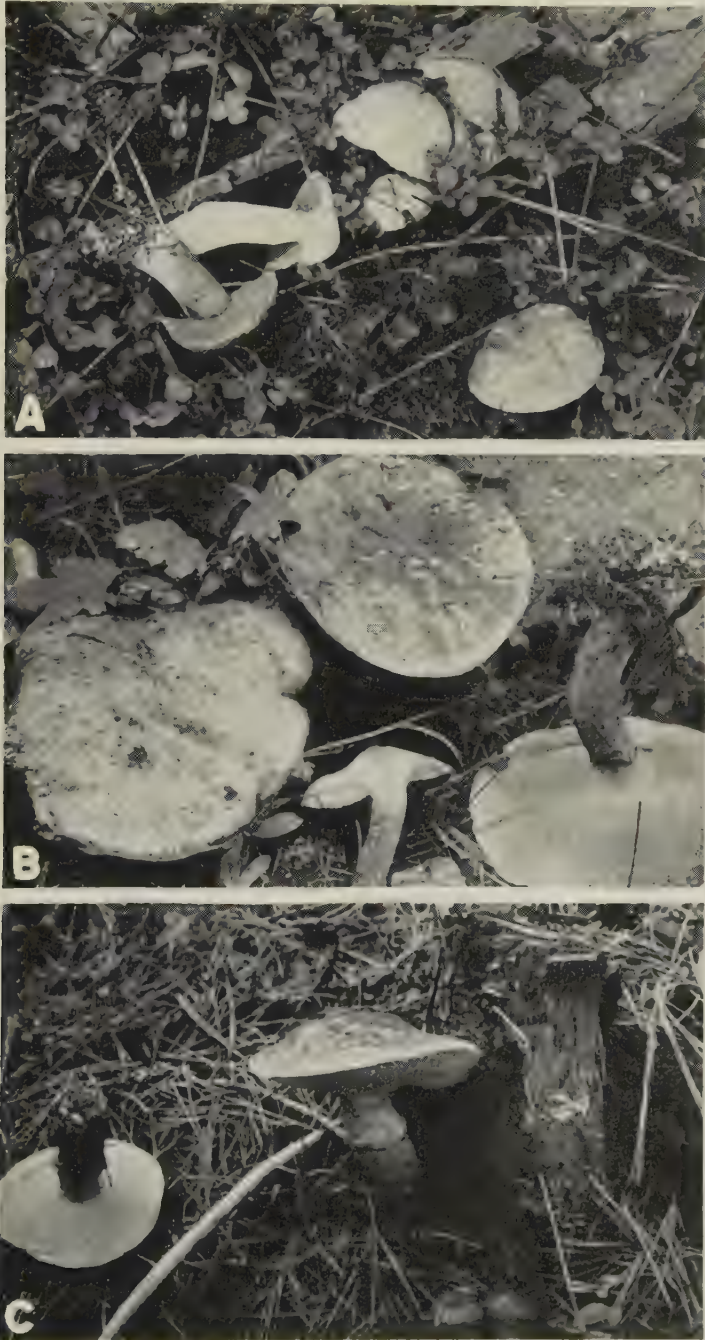


PLATE 2. (See opposite page for explanation.)

MYCORRHIZAE.—Reported on *Larix decidua* (Melin, 1922), *L. sibirica*, and *L. leptolepis* in Sweden (Romell, 1921), *L. decidua* in Britain (How, 1942) and Italy (Peyronel, 1920, 1922), and has produced mycorrhizae experimentally on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940), the latter indicating that the species may not be strictly limited in its mycorrhizal relationships to species of *Larix* as Melin (1922) suggested.

EDIBILITY.—Kallenbach (1926-37) states that *S. elegans* (as *Boletus flavus*) is delicate and savory, but Peck (1889) believes that, though it is edible, it is not delicate.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1685, 1930, 1973, 2009, 2564, 2566, 3048, 3084, 3205, 3253 (Idaho).

8. *Suillus* ? *subaureus* (Peck) Snell, comb. nov.

Boletus subaureus Peck

Plate 3, fig. A; and Plate 7, fig. H.

SELECTED ICONES.—Peck (1900, pl. 61); Güssow and Odell (1927, pl. 97).

HABIT.—Gregarious. PILEUS—*Shape*: convex. *Margin*: when young, slightly grayish-tomentose. *Diameter*: 5-11 cm. *Surface*: viscid to glutinous when wet, glabrous when dry; color pale, dull yellow, or buffish yellow, sometimes with darker spots from drying of the gluten which is usually reddish in wet weather, occasionally vermilion streaked; our collection yellowish buckskin (11K4), with tiny brown patches evenly distributed. *Flesh*: firm; color pale yellow, or lemon yellow (10J1); taste mild, not distinctive, or pleasant; odor slightly acid. *Tubes*: adnate to subdecurrent, in our collection adnexed; color a yellowish buff (10J4) when young, to dull canary yellow (11L4) at maturity, walls glandular-dotted; mouths somewhat angular to irregular, diameter to 1 mm., mostly smaller, glandular-dotted, exuding yellow drops which darken with age. STIPE—*Shape*: subequal, stout. *Annulus*: none. *Reticulation*: none. *Surface*: usually dry, closely glandular-dotted; color yellow, brownish yellow, or pale buff at the base, covered with yellowish to reddish brown glandules which darken with age. *Interior*: solid; color yellow, but darker yellow to orange, or deep reddish toward base. *Length*: 4-7 cm. *Diameter*: 0.8-1.8 cm. SPORES—*Color in mass*: fawn brown, or ochraceous-ferruginous. *Shape*: elliptical to somewhat subfusiform. *Color under microscope*: hyaline. *Dimensions*: 7-10×3-4μ, mostly 7.5-8.5×3μ. CYSTIDIA—*Shape*: clavate to irregular, or more or less fusiform. *Color under microscope*: hyaline. *Dimensions*: 40-70×6-8μ.

REMARKS.—Specimens of this species marked on the pileus with streaks or patches of red brown or vermilion may be *Suillus subaureus* (Peck) Snell var. *rubroscriptus* Peck. This form has not been found in the course of this study.

Since specimens collected in this region do not conform strictly to descriptions of *S. subaureus*, this identification must be accepted with minor reservations. Despite this uncertainty it was thought best to include the description and give the species a place in the keys.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: the tops of the pilei wrinkle severely, the patchy character of the surface being completely lost. Stipes furrow extensively, the glandules often being barely discernible without a hand lens. Colors are seriously degraded. *Color of pileus*: light umber brown (15C9), with irregular areas lighter (approximately 14J9). *Color of tube surface*: suntan khaki (13L7), the tube mouths dark brown, dulling the color of the whole tube surface. *Color of stipe*: a light grayish brown (approximately 14G8), darkened, in some cases almost black, by the blackish glandules.

DISTINGUISHING CHARACTERISTICS.—This species has been commonly confused with *Suillus americanus* which it closely resembles when the pileus is marked by reddish gluten. *S. americanus* is characterized by brighter yellow color than the dull yellow to buffish yellow of *S. subaureus*. Its stipe is also thinner. Specimens of *S. subaureus* collected in this region have been lacking in reddish gluten and are rather difficult to distinguish from *S. granulatus*, as indicated by those shown in Plate 3, fig. A. Color of *S. subaureus* is generally more yellowish and lighter than *S. granulatus*, and the stipe is entirely yellow, or perhaps discolored somewhat, yellow within, with the flesh reddish or dark red at the base, while the stipe of *S. granulatus* is yellow at the top, white below beneath the glandular dots, and white within. Both are found under lodgepole pine, reach their optimum development at the same time, and are frequently closely similar.

HABITAT NOTES.—This species has been observed only in consociations dominated by *Pinus contorta* var. *latifolia* in this region. While only one collection was made, specimens were frequently observed during intensive collection of the study area in this consociation, growing on duff, humus, and mineral soil. The typical associate is undoubtedly *P. contorta* var. *latifolia*. Optimum development is usually between late September and early November. No specimens have been observed in the spring.

MYCORRHIZAE.—No record found.

EDIBILITY.—Reported edible by Güssow and Odell (1927). These authors state that the species is regarded by some authors as "among the most valuable of our [Canada] food species, being found when other fungi are scarce." In this region appearance of the species coincides with the optimum season for the majority of the fleshy fungi. Güssow and Odell regard *S. americanus* as a synonym, and their remarks concerning edibility include that species.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3261 (Idaho).

9. *Suillus granulatus* (L. ex Fries) Snell, comb. nov.*Boletus granulatus* L. ex Fries

Plate 4, fig. A; and Plate 7, fig. J.

SELECTED ICONES.—Farlow (1929, pl. 75); Hard (1908, fig. 283); Murrill (1913, pl. 80, figs. 3, 4; 1916, fig. 5); Güssow and Odell (1927, pl. 93); Kallenbach (1926 37, pl. 48); Michael-Schulz (1927, pl. 272); Juillard-Hartmann (1919 et seq., 4: 191 (6)); Bresadola (1931, pl. 907); Migula (1925, pl. 45D); Jaccottet (1925, pl. 60); Macku (1925, fig. 135).

HABIT.—Gregarious, sometimes solitary, rarely caespitose. PILEUS—*Shape*: convex. *Margin*: when young, occasionally fibrillose-appendiculate, particularly in wet weather. *Diameter*: 4–20 cm., but rarely larger than 10 cm. in this region. *Surface*: very viscid when wet, often obscurely virgate-spotted, especially near the center in larger specimens; color extremely variable, in this region from a metallic burnt umber (15A12), or perhaps somewhat lighter, when very young, through shades of light chamois to pale old ivory (11G5 to 10F3), becoming paler with age; in other regions reddish brown, pinkish gray, fading to yellowish white or white with brownish stains when rain washed. *Flesh*: firm, becoming soft in large, old specimens; color pure white when young, later pale yellow near tubes and white above, or occasionally pale yellow throughout, becoming brownish with age, unchanging; taste mild, somewhat mucilaginous; odor faintly acid to occasionally somewhat fetid. *Tubes*: adnate, rarely slightly subdecurrent; color pale creamy yellows (9I2 to 9I4), rarely dirty yellowish in large, old specimens, unchanging; mouths subrotund to irregular, compound, conspicuously glandular-dotted in other regions, occasionally so in our collections, the glandules appearing granular, lending a brownish cast to the tube surface, diameter of mouths 0.25–1 mm., usually 0.25–0.5 mm. STIPE—*Shape*: subequal, or tapering upward. *Annulus*: none; but very rarely a small, evanescent false annulus is present in this region near apex of stipe, disappearing well before maturity. *Reticulation*: none. *Surface*: finely glandular-dotted from apex downward usually less than half the length, dry, rarely somewhat moist; color varying from chalky white to pale sandy brown, yellow near apex, stained pinkish to brownish in age, the glandules yellow to pinkish brown, darker on drying. *Interior*: solid; color white to pale yellowish. *Length*: 2–8 cm. *Diameter*: 0.6–3 cm., usually 1.5–2 cm. SPORES—*Color in mass*: yellowish brown. *Shape*: elliptical. *Color under microscope*: hyaline. *Dimensions*: 6–10 × 2.5–3.5 μ , mostly 6–7 × 2.5–3 μ , perhaps 7–8 μ in some specimens. CYSTIDIA—Clustered at the mouths to form glandular-dots, or single in the hymenium. *Shape*: clavate. *Color under microscope*: hyaline, occasionally more or less yellowish on stipe. *Dimensions*: 45–90 × 7–15 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: mod-

erate to extreme, surface of the pilei wrinkling severely, large, soft specimens becoming almost worthless. *Color of pileus*: sun tan khaki (13L7), warm brown (14L11) to chocolate brown (8H10), the latter in large, soft specimens. *Color of tube surface*: bronze brown to dull golden tan (14K9 to 13L8), the mouths dark brown, giving the tube surface a strong brown cast. *Color of stipe*: shades of dark brown, the blackish glandules usually visible without a hand lens.

DISTINGUISHING CHARACTERISTICS.—The color of this species, usually some shade of brown, is so variable that, at first glance, several variations may be mistaken for different species. The surface is thickly viscid when wet, old specimens appearing virgate-spotted beneath the glutinous coating. The stipe offers the most dependable means of separating it from the closely similar *Suillus* ? *subaureus*, being yellow at the apex, white below, and usually white within, while that of the latter is yellow for its whole length, or discolored, and reddish or pinkish within, at least at the base. Diameter of the pileus also varies widely, the range in association with *Pinus contorta* var. *latifolia* being 5–10 cm., while specimens as large as 20 cm. across have been collected in other associations. Specimens shown in Plate 4, fig. A, were photographed during dry weather and show no evidence of viscosity. The margin of the pilei of these specimens is fibrillose-appendiculate, a comparatively rare character, and the stipe shown is unusually short.

HABITAT NOTES.—This species is found in all stages of the forest succession in the *Thuja-Tsuga* zone, except thinly-stocked burns. Observation over the past four years has led to the conclusion that *Pinus contorta* var. *latifolia* is perhaps the most important associate, although occasional association with several tree species is indicated by records of the individual collections. In consociations dominated by *P. contorta* var. *latifolia*, *S. granulatus*, at its optimum season, is not only the commonest bolete, but outnumbers all other species of the family ten to one. It appears in its greatest concentration when fall rains have thoroughly saturated the litter accumulation, but occasional collections have been made during wet weather as early as July. The largest specimens were found in nearly climax stands of *Thuja-Tsuga* which included large *Pinus monticola* approximately 200 years old.

MYCORRHIZAE.—*S. granulatus* has been reported probably forming mycorrhizae on *P. radiata*, *P. patula*, *P. echinata*, and *P. longifolia* in Australian plantations (Young, 1936), and producing mycorrhizae experimentally on *Araucaria cunninghamii*, *Pinus caribaea*, *P. taeda* (Young, 1940), *P. Strobus*, *P. Mugo* (Hatch and Hatch, 1933), *P. merkusii* (Rayner, 1938), *P. radiata* (Walker, 1931), and *P. sylvestris* (Melin, 1923a).

EDIBILITY.—Edibility of this species is well established, but there is some difference of opinion as to its desirability. Peck (1889) repeats

Badham's assertion that it has a flavor similar to that of *Boletus edulis*, considered among the best of edible fungi. Others report that it is slimy, but this, perhaps, can be minimized by removing the tube layer and peeling the pileus before cooking. Farlow (1929) and McIlvaine (1902) agree that it is highly regarded as an edible species.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1542, 1543, 1598, 2568, 2569, 2570, 2586, 2617, 2626, 3236, 3239, 3243, 3661, 3662 (Idaho).

10. **Suillus subluteus** (Peck) Snell, comb. nov.

Boletus subluteus Peck

Plate 3, figs. B and C; and Plate 7, fig. K.

SELECTED ICONES.—Peck (1897, pl. 33); Farlow (1929, pl. 71); Hard (1908, fig. 297).

HABIT.—Usually solitary, occasionally gregarious. PILEUS—*Shape*: broadly subconic to convex, rarely almost applanate. *Margin*: often partly appendiculate with veil remnants. *Diameter*: 4–10 cm. *Surface*: viscid or glutinous when moist, glabrous when dry, but characteristically rather strongly fibrillose-virgate; color varying from bronze (14L9), through an olivaceous khaki (14L6) to olivaceous golden yellow (12L6), the darker fibres contrasting with the lighter color beneath. *Flesh*: firm, rarely soft; color pale to dull yellow, grayish ivory in old specimens, no color change; taste pleasant to faintly acid; odor somewhat farinaceous to slightly acid. *Tubes*: adnate, sometimes adnexed; color light sulphur yellow (9K1) when young, a dull olivaceous yellow in age (12L3); mouths subrotund to irregular, 0.5–1.5 mm. diameter, conspicuously glandular-dotted, as are the tubes, the glandules light colored and inconspicuous when young, becoming brown and extremely conspicuous when old, dulling the color of the tube surface. *Veil*: submembranous, glutinous, more or less rolled at the bottom, slaty gray, collapsing to form the annulus. STIPE—*Shape*: moderately slender, subequal to tapering slightly upward. *Annulus*: usually wide, appressed-cylindric, shiny, fibrillose-virgate, viscid to glutinous when wet, persistent; may be narrow, inconspicuous, or even lacking, but rarely so in this region. *Reticulation*: none, or rarely near apex from decurrent tube dissepiments. *Surface*: densely and conspicuously glandular-dotted, the glandules frequently confluent into irregular patches measuring 2 or 3 mm. across; color yellow at apex, white at base, the colors dulled in varying degree by the glandules which darken with age, becoming greenish brown at maturity; many specimens possess such dense glandular-dots that the stipe color becomes predominantly greenish brown. *Interior*: solid; color pale to dull yellow, more yellow than the flesh of the pileus, deeper toward base. *Length*: 6–10 cm. *Diameter*: 1–2 cm. SPORES—*Color in mass*: ochraceous-ferruginous to cinnamon brown. *Shape*: elliptical to elliptic-fusiform.

Color under microscope: pale yellow. *Dimensions*: $8-13 \times 2.5-4\mu$, mostly $8-10 \times 3\mu$. CYSTIDIA—Two forms, caespitose at mouths of tubes, and rare in the hymenium. Caespitose at mouths of tubes. *Shape*: clavate, or cylindric-clavate. *Color under microscope*: yellow. *Dimensions*: $50-60 \times 7-8\mu$. Rare in the hymenium. *Shape*: clavate. *Color under microscope*: hyaline. *Dimensions*: $28-30 \times 7-8\mu$. BASIDIA—*Shape*: cylindric to clavate. *Dimensions*: $21-26 \times 7-9\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: shrinkage is only moderate, but the surface of the pilei becomes deeply wrinkled, the fibrillose-irregular character being lost completely, except in rare specimens. The annulus remains conspicuous; and the glandules almost completely cover the stipe surface in most specimens, turning black. *Color of pileus*: suntan khaki (13L7) to bronze (14L9 or 14L10), the surface glossy. *Color of tube surface*: bronze (14L10), but darkened by the blackish tube mouths. *Color of stipe*: blackish brown from the dried glandules, small areas ivory at irregular intervals; annulus bronze, or yellowish.

DISTINGUISHING CHARACTERISTICS.—See the description of *Suillus luteus* for distinctions between it and this closely related species. *S. subluteus* is readily identified among other species described here by its usually appressed-cylindric, glutinous annulus 1-2 cm. wide, and the stipe bearing the densest, most conspicuous glandular-dots of any bolete found in the region, the glandules dark greenish brown when mature. *S. americanus* approaches this species in density of glandular dots on the stipe, but its stipe is much more slender, is hollow at maturity in this region, and rarely is annulate; also the pileus is a brighter yellow, commonly with brownish red patches. Specimens pictured in Plate 3, figs. B and C, show the appressed-cylindric annulus on both immature and mature individuals. Figure C shows the fibrillose-irregular nature of the mature pileus, and remnants of the veil may be seen on margins of the pilei in both figures. Both figures show the dense glandular-dots on the stipe, darkening with age.

HABITAT NOTES.—Found in almost all associations of the *Thuja-Tsuga* zone, this species also appears in the subalpine *Picea-Abies* zone in this region. In the former zone it has been collected in young consociations of *Pinus contorta* var. *latifolia* on areas burned over about 15 years earlier, and almost at the other extreme of the forest succession, in nearly climax associations of *Thuja-Tsuga* with *P. monticola* over 200 years old. Although *Thuja* was found near most specimens collected, the species is apparently not limited in association to this tree, *P. monticola* and *Larix* also being occasional associates. Collections have been made between September 15 and October 31, but it has not been observed in the spring during the period of this study. Earliest occurrences were during a season in which fall rains began in the latter part of August, somewhat earlier than in a normal

year. It is probable that optimum moisture conditions on the forest floor are reached between 3 and 4 weeks after fall rains begin in this region, unless precipitation is unusually deficient. Fruiting bodies develop in the duff, humus, and mineral soil, and are usually found under the forest canopy rather than along roadside banks and trails.

MYCORRHIZAE.—No reports found.

EDIBILITY.—Although the species is edible, no reports concerning its quality could be found.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2572, 2585, 2613, 3265, 3659 (Idaho).

11. *SUILLUS LUTEUS* (L. ex Fries) S. F. Gray

Boletus luteus L. ex Fries

Plate 7, fig. L.

SELECTED ICONES.—Peck (1897, pl. 33); Murrill (1916, fig. 10; 1920' pl. 2, fig. 1); Atkinson (1903, figs. 173, 174); Kallenbach (1926-37, pls. 19' 24, 25); Michael-Schulz (1927, pl. 85); Bresadola (1931, pl. 901); Macku (1925, fig. 136); Migula (1925, pl. 42C).

HABIT.—Solitary, or caespitose. **PILEUS**—*Shape*: rounded-pulvinate, approaching hemispherical, to plano-convex. *Diameter*: 4-13 cm. *Surface*: smooth, shining, extremely glutinous, or slightly sticky-viscid in dry weather, virgate-streaked on drying; color grayish brown, yellowish brown, reddish brown, to chocolate brown, often with variations of yellow and brown, or with a sallow cast, becoming darker and duller with age, our single collection dark honey-colored (approximately 12J6). *Flesh*: soft-cottony, often watery; color at first whitish, then lemon yellowish with age, especially near the tubes, becoming tinged with dull reddish brown when cut; taste mild, not distinctive; odor faintly acid, or not distinctive. *Tubes*: adnate, or slightly decurrent, seceding in our collection; color bright lemon to golden yellow, darker with age; mouths irregular, angular, glandular-dotted, 1-1.5 mm. diameter. *Veil*: membranous, sheathing the stipe, at first white, thick, then thinner as it dries, becoming grayish, withdrawing upward to form the annulus. **STIPE**—*Shape*: tapering upward to subequal. *Annulus*: prominent, usually flaring upward, particularly when young, glutinous, gray, to dark violet, or blackish brown in some forms, yellowish to brownish in others, yellow brown on upper side. *Reticulation*: more or less, at very apex. *Surface*: pruinose to glandular-dotted above and below annulus, especially above; color at first pale yellowish, then yellow at apex, white, or buff at base, the glandules brownish

PLATE 3. Figure A. *Suillus ? subaureus* (Peck) Snell, UIFP 3261. B. *Suillus subluteus* (Peck) Snell, UIFP 2613. C. *Suillus subluteus* (Peck) Snell, UIFP 3265.



PLATE 3. (See opposite page for explanation.)

or yellowish. *Interior*: solid, fibrous; color like flesh of pileus, but grayish, or brownish at base and near cortex, or brighter yellow and flesh-colored in streaks. *Length*: 3–11 cm. *Diameter*: 1–2.5 cm. SPORES—*Color in mass*: rusty ochraceous brown when fresh, drying to dull ochraceous brown. *Shape*: almost elliptical to elliptic-fusiform. *Color under microscope*: pale yellow. *Dimensions*: $6\text{--}11 \times 2.5\text{--}4\mu$, mostly $8\text{--}9 \times 3\mu$. BASIDIA—*Shape*: clavate. *Dimensions*: $21\text{--}25 \times 6\text{--}7\mu$. CYSTIDIA—Clustered at the mouths, making glandular-dots, and single in the hymenium. *Shape*: saccate-clavate to somewhat rostrate. *Color under microscope*: hyaline, pale yellow, to dark brownish. *Dimensions*: $24\text{--}60 \times 6\text{--}14\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: our single collection shrank approximately 50% in volume, with moderate distortion, colors darkened considerably, pilei becoming umber brown, tube surfaces cinnamon brown, or somewhat darker, stipes blackish brown, lighter in places. No color comparisons determined.

DISTINGUISHING CHARACTERISTICS.—Closely related to *S. subluteus*, this species has a thicker stipe, the ratio of stipe diameter to cap diameter being about 1:5, while that of *S. subluteus* is between 1:8 and 1:10. Stipes of both are glandular-dotted, but glandules are more conspicuous above the annulus in *S. luteus*, below the annulus in *S. subluteus*, in which they are large, confluent, and frequently almost hide the cuticle toward the base. In the latter the annulus collapses at maturity, or somewhat earlier, while it is strongly flared upward in *S. luteus*, frequently persistently so. *S. luteus* also commonly has reticulations at the apex of the stipe. It is possible that this species might be confused with glabrous forms of *S. hirtellus* var. *mutans*, where abnormally dark specimens of that species are concerned. Flesh of both pileus and stipe of the latter changes to blue when cut or broken, and its stipe has no annulus.

HABITAT NOTES.—The single collection of *S. luteus* was found in an association of *Larix*, *Pinus monticola*, and *Pseudotsuga*, with no indication of the typical associate. The collection was made in June and the species has not been observed in any other part of this region during the past four years.

MYCORRHIZAE.—Reported on *Pinus montana* (Romell, 1921), *P. nigra* var. *austriaca* (Rayner, 1927), and *P. sylvestris* (Rayner, 1927; Rayner and Levisohn, 1941). It has produced mycorrhizae experimentally on *P. caribaea*, *P. taeda* (Young, 1940), *P. contorta* var. *latifolia*, *P. nigra* (Rayner, 1934), *P. radiata* (Rayner, 1938), *P. Mugo*, *P. Strobus*, *Picea Abies*, *Larix decidua*, and *L. occidentalis* (Hatch and Hatch, 1933). Two of the tree species on which mycorrhizae were produced experimentally are members of the seral association in the *Thuja-Tsuga* zone in this region, *Larix occidentalis* and *Pinus contorta* var. *latifolia*, the former occurring in the association from which our collection was made.

EDIBILITY.—Kallenbach (1926-37) states that this species is equal in quality to *Suillus elegans*. Peck (1889) says the flesh is tender, but the tubes should be scraped away, as in all species, before cooking.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3050 (Idaho).

12. *Suillus americanus* (Peck) Snell, comb. nov.

Boletus americanus Peck

Plate 4, figs. B and C; and Plate 7, fig. M.

SELECTED ICONES.—Murrill (1913, pl. 80, fig. 5, as *Rostkovites subaureus*); Farlow (1929, pl. 73); Atkinson (1903, fig. 171); Hard (1908, fig. 304); White (1905, pl. 29).

HABIT.—Gregarious. PILEUS—*Shape*: convex, frequently subconic or subumbonate. *Margin*: more or less thickly tomentose-appendiculate when young. *Diameter*: 5-10 cm., mostly 5-8 cm. *Surface*: glabrous, sticky-viscid, but thinly so; color dandelion yellow (9L4) when young, to dull canary yellow (11L4) when old, more or less irregularly-patchy, or streaked, with pinkish brown (6F10) to reddish brown (7L8), or rarely more reddish; the patches, or streaks, often sparse, or even lacking, but frequently covering over half the surface. *Flesh*: firm when young to soft when old; color lemon to mustard yellow, darkening somewhat with a pinkish roseate hue when cut or broken; taste somewhat resembling raw turnip, but often mild, not distinctive; odor mildly acid. *Tubes*: adnate, rarely adnexed, or even subdecurrent; color warm lemon yellow (10K4) to a dull olivaceous yellow (12L3), changing to brownish yellow on injury, the walls and mouths glandular-dotted; mouths angular, irregular, 0.5-1.5 mm. diameter. *Veil*: thickly tomentose, separating early from the stipe, adhering to the margin of the pileus, sometimes leaving an annulus. STIPE—*Shape*: slender, subequal, to tapering slightly downward. *Annulus*: tomentose, well-defined in some specimens, but none in about half the collections. Eastern forms of the species have no annulus. *Reticulation*: near apex from decurrent tube dissepiments, many individuals with none. *Surface*: glandular-dotted, the glandules varying from very small and widely separated, to large, confluent, and conspicuous, covering the major portion of the surface in some old specimens; moist to sticky; color lemon to mustard yellow, usually more or less masked by the brown glandular-dots, which often color the whole a dirty greenish brown; extreme base usually sheathed in pinkish white, closely appressed mycelium. *Interior*: solid when young, but in this region almost always hollow when mature, chiefly at the base; color lemon to mustard yellow, becoming faintly pinkish roseate when cut or broken, one only of four collections changing to blue at base when cut. *Length*: 6-9 cm. *Diameter*: 0.8-2 cm., the latter rarely, mostly 0.8-1.5 cm. SPORES—*Color in mass*: cinnamon brown. *Shape*:

elliptical to subfusiform. *Color under microscope*: pale yellowish to golden brown. *Dimensions*: $8-11 \times 3.5-4.5\mu$, mostly $9-10 \times 4-4.5\mu$. CYSTIDIA—Numerous, clustered in glandular-dots in the hymenium and at tube mouths. *Shape*: usually strangulated, or distorted, rarely cylindric-clavate. *Color under microscope*: golden brown, or hyaline. *Dimensions*: $50-60 \times 6-8\mu$.

REMARKS.—Hollow stipes have apparently not been reported for this species from any other region, although nearly every specimen collected in the course of this study exhibits this peculiarity.

The annulus found on many of these specimens is also not reported from other regions. Examination of 44 dried specimens representing four collections revealed 22 with no annulus, 19 with at least a fragmentary annulus, and only 3 with a complete annulus.

Also one of the four collections exhibited a change to blue at the base of the stipe when cut, a feature not before reported. Despite these three differences from the characteristic eastern form, establishment of a new species, or even a variety is not considered justified, since the collections conform perfectly to the original descriptions in all other respects.

Plate 4, fig. B shows the tomentose margin of the young pileus and a typical hollow stipe. Note the comparatively sparse markings on the pilei in this 1942 collection. Fig. C shows a 1940 collection, with much more conspicuous red brown patches or streaks on the pilei. These two photographs were made from the same camera position, although taken two years apart. The specimens undoubtedly arise from the same substratum, and perhaps the same mycelium.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: severe, the surface of the pilei wrinkling badly, and the margins twisting more or less severely. Patches and streaks on the surface are usually clearly discernible; glandular-dots on tube walls and mouths remain conspicuous; the annulus, when present, is plainly visible, and the stipe glandules are extremely conspicuous; the cavity in the stipe is large and obvious when the stipe is broken at the base. *Color of pileus*: light ochre yellow (11L6), olivaceous golden yellow (12L6), or somewhat darker. *Color of stipe*: black, over all, or most, of the surface from the dried glandules, usually with scattered spots of gray, or yellowish gray showing through; the annulus, where present, buff, or yellowish.

DISTINGUISHING CHARACTERISTICS.—This is the only species collected in the region which stains the hands yellow with the gluten from the top of the pileus. The unusually slender and tough stipe is its most valuable diagnostic characteristic. The stipe is usually densely glandular-dotted,

PLATE 4. Figure A. *Suillus granulatus* (L. ex Fries) Snell, UIFP 2569. B. *Suillus americanus* (Peck) Snell, UIFP 3658. C. *Suillus americanus* (Peck) Snell, UIFP 2578.

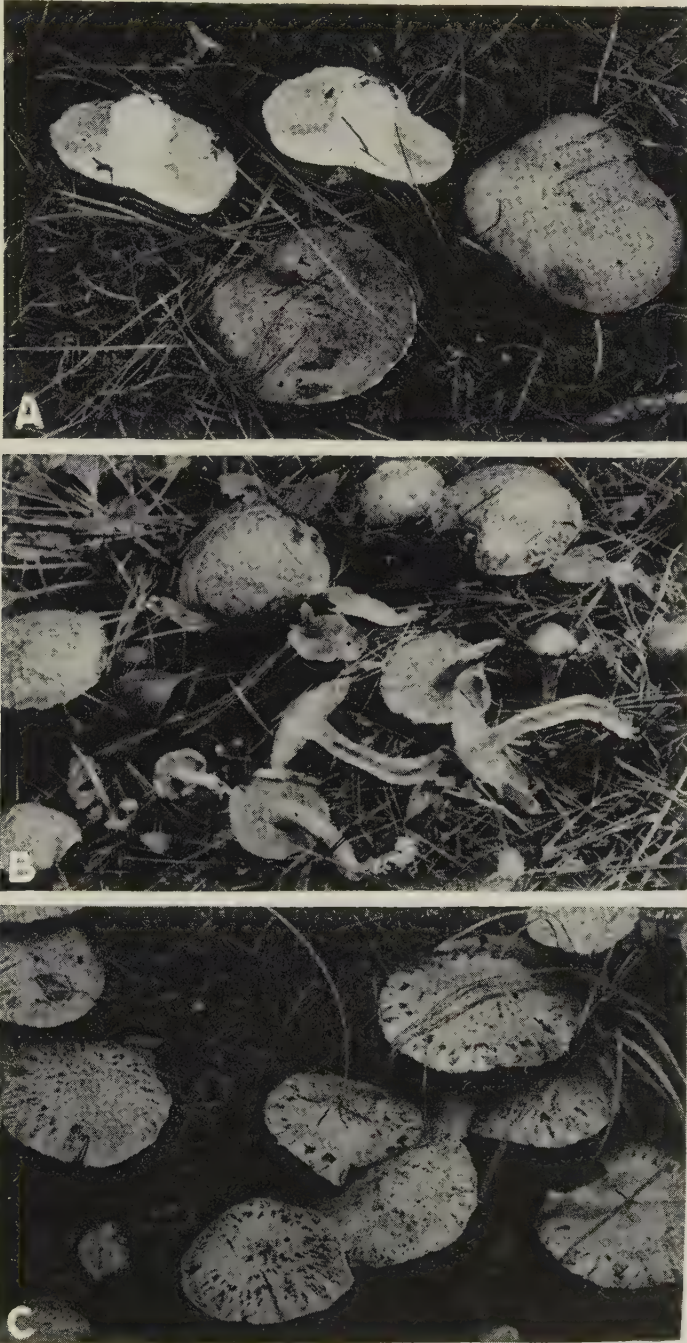


PLATE 4. (See opposite page for explanation.)

the base commonly sheathed in pinkish mycelium, and the margin of the young pileus appendiculate with thick tomentum. In mature specimens the base of the stipe is almost always hollow in this region.

HABITAT NOTES.—This species occurs in consociations dominated by *Pinus monticola* in this region. It was collected in four localities only, in stands between the ages of 10 and 80 years, the best development noted occurring along Benton Creek, in the Priest River Experimental Forest. The remaining localities were all within two miles of this point, the species having been seen in no other part of the region during the past four years. It has not been observed in the spring, all collections occurring between mid-September and late October. *P. monticola* is apparently the typical tree associate.

MYCORRHIZAE.—No reports found.

EDIBILITY.—Reported edible by Farlow (1929). See *Suillus* ? *sub-aureus* for further discussion.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2578, 3638, 3648, 3658 (Idaho).

- b. Pileus dry, never viscid; glabrous, subpruinose or subtomentose; tubes simple or compound; spores subfusiform.

XEROCOMUS Quélet

Pileus dry, never viscid, may be glabrous, subpruinose, or subtomentose; tubes simple or compound, never stuffed or with red mouths; spores subfusiform; stipe rugose or striate in some species, never truly reticulate or bulbous.

1. Stipe some shade of red, at least in part..... 2
Stipe yellow or brown, not red..... 5
2. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow; pileus dark greenish brown; stipe deep crimson to brownish red..... 13. *X. Zelleri*
Tube surface turning blue where bruised..... 3
3. Stipe uniformly red at base, yellow at apex; pileus khaki, rimose-areolate..... 16. *X. sp.*
Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown..... 4
4. Pileus rose, beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow..... 17. *X. sp.*
Pileus warm brownish khaki to dull brown with mustard-colored bloom, subtomentose, not rimose, or rarely deeply rimose-diffract, at least in part; stipe pinkish brown, or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species..... 14. *X. subtomentosus*
5. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract..... 15. *X. ? pulverulentus*
Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard-colored bloom, subtomentose; not rimose, or rarely deeply rimose-diffract, at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species.....
..... 14. *X. subtomentosus*

13. **Xerocomus Zelleri** (Murrill) Snell, comb. nov.*Ceratomyces (Boletus) Zelleri* Murrill

Plate 5, fig. A; and Plate 8, fig. A.

SELECTED ICONES.—Zeller (1914, pls. 140, 141).

HABIT.—Usually gregarious, frequently caespitose. PILEUS—*Shape*: convex, rarely plano-convex. *Diameter*: 4–18 cm., usually 6–12 cm. *Surface*: appearing glabrous when wet, when dry plainly pruinose with a very delicate, inconspicuous bloom usually disappearing with age; cuticle rarely cracks, in some cases widely, but not deeply, the cracks light buff; dry, rarely moist; color a dark, more or less metallic bronze brown (approaches 16E12), without lustre, the most metallic individuals resembling very badly tarnished brass; the greenish cast due to the fine bloom which, when present, may be rubbed off, revealing a dull, olivaceous brown; in other regions may be Prussian red, seal brown, or cameo brown, the margin usually somewhat paler and browner. *Flesh*: firm; color varying in different specimens from ivory (10B2), through shades of pale yellow (10C1 to 10J1) to lemon yellow (10K3), pinkish under cuticle and near stipe in most cases, the pink color sometimes showing through cracks in the cuticle, a thin hygrophanous line usually marking the junction between tubes and flesh; color changes to blue, but very slowly, the change not appearing before 10 to 30 minutes following cutting, some individuals showing no color change; taste slightly acid, or somewhat mucilaginous; odor mild, not distinctive. *Tubes*: adnexed to adnate-depressed; color light sulphur yellow (9K1) when immature, dulling with age to a somewhat olivaceous yellow (12L1) in very old specimens; no change to blue noted on the tube mouths following injury in any collection although one old but still firm individual when collected had large, irregular, blue patches on the tube surface; mouths irregular in shape, compound, rotund to subangular, 1–2 mm. diameter. *Veil*: none at any stage of development. STIPE—*Shape*: subequal, or tapering upward. *Annulus*: none. *Reticulation*: none. *Surface*: glabrescent, appearing finely striate with a vertical fibrous pattern; color in shades of red from deep garnet red (6K6) to brownish ruby red (7H6), the latter rarely, sometimes yellow brown at base. *Interior*: solid; color lemon to golden yellow when young, with indefinite reddish areas which increase with age, a zone of red extending approximately to 2 mm. beneath the surface; color changes to blue, sometimes very bright, but only after 10 to 30 minutes following cutting, some individuals showing no color change. *Length*: 5–10 cm. *Diameter*: 1–4 cm. SPORES—*Color in mass*: olive brown. *Shape*: elliptic-subfusiform. *Color under microscope*: pale greenish, or yellowish. *Dimensions*: 9–15 × 4–6 μ , mostly 12 × 4.5 μ . CYSTIDIA—Numerous. *Shape*: variously irregular-cylindrical, lageniform, to narrowly ventricose-rostrate, or even clavate. *Color under microscope*: hyaline. *Dimensions*: 40–60 × 7–15 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: usually moderate, pilei wrinkling somewhat in most cases. Color and texture of pilei and stipes, particularly the latter, are frequently well preserved, with little change. *Color of pileus*: light grayish olive (14E4), dark olive brown (15L8) to dark umber brown (16A11), the latter rarely; cracks in cuticle sometimes reddish; surface usually dull due to bloom, rarely somewhat glossy. *Color of the tube surface*: approaching dull canary yellow (11L3 or 11L4) in very young specimens, olivaceous golden yellow (12L6), or more commonly shades of suntan khaki to olivaceous umber brown (13L7 to 15H11). *Color of stipe*: maroon (7L7), or darker red, to reddish brown, the latter rarely. The red color of the stipe is commonly brighter in young specimens, tending toward brown in overmature specimens.

DISTINGUISHING CHARACTERISTICS.—The stipe deep red, pileus dull metallic, greenish brown, usually resembling badly tarnished brass, and the tube surface yellow make this a striking species. Among the species collected it resembles only number 16. *Xerocomus* sp., which is closely similar in color. The latter, however, has a consistently rimose-areolate pileus, its stipe is usually considerably more slender, and the flesh changes to blue much more rapidly when cut or broken. Both species have been collected in the same habitat. Plate 5, fig. A, pictures a closely caespitose group, a condition encountered occasionally.

HABITAT NOTES.—This species is characteristic of the climax forest association of the *Thuja-Tsuga* zone. In fact, since it is apparently limited to this association, this should be noted as a distinguishing characteristic. Only one collection was made on a site not occupied by a climax, or nearly climax, association, in an area which had been burned 16 years earlier. These specimens were in close proximity to a patch of *Tsuga* reproduction, however, the burn being rather sparsely covered with reproduction of this species, *Larix occidentalis*, *Pinus monticola*, and a few *Thuja plicata*, the conifers scattered among shrubby species of *Salix*. It has not been concluded whether this species is most commonly associated with *Thuja* or *Tsuga*, but it has been observed occurring where *Tsuga* alone was present within 15 meters (approx. 50'). In a normal season optimum development occurs during late September and through October, individuals appearing until freezing weather begins. The earliest collection was made on July 7 in a wet season.

MYCORRHIZAE.—No record was found, but UIFP 2707 was attached directly to the root collar of a living seedling, 2 feet in height, of *Pinus monticola*. The seedling showed pronounced mycelial development in all cracks in the root epidermis and all short roots left attached were mycorrhizal.

EDIBILITY.—Not reported in the literature.

COLLECTIONS.—U. of Idaho For. Path. Herb. 1595, 2582, 2614, 2696, 2707, 3664 (Idaho); 2632, 2684, 3656 (Wash.).

14. XEROCOMUS SUBTOMENTOSUS (L. ex Fries) Quélet

Boletus subtomentosus L. ex Fries

Plate 5, fig. B; and Plate 8, fig. B.

SELECTED ICONES.—Farlow (1929, pl. 79); Hard (1908, fig. 284); Bresadola (1931, pl. 914); Michael-Schulz (1927, pl. 88); Juillard-Hartmann (1919 et seq., 4: 192 (6)); Murrill (1910, pl. 19, fig. 6); Soc. Myc. Fr. (1931, pls. 42, 43); Migula (1925, pl. 43B); Macku (1925, fig. 131).

HABIT.—Usually gregarious, sometimes solitary. PILEUS—*Shape*: convex, often plane. *Diameter*: in this region commonly 15–25 cm., but usually 3–15 cm. in other regions. *Surface*: subtomentose, tomentose, to villose-tomentose, not rimose, sometimes rimose-areolate, at least in part, or very rarely deeply rimose-diffract, moist, or dry; color bronze (14L8) to cocoa brown (15C11), with a mustard-colored bloom in our collections, in other regions variously yellowish brown, tawny olive, brownish olivaceous yellow, or reddish brown, the chinks, as in ours, yellow. *Flesh*: firm; color pale lemon (10J2) to paler yellow, occasionally with a brownish zone beneath cuticle, changing to blue after some time where the cut surface is bruised, but never suddenly or deeply, or rarely unchanging; taste and odor mild, not distinctive. *Tubes*: adnate, usually narrowly so, or slightly depressed, perhaps slightly decurrent, or, as in many of ours, with tube dissepiments prominent, descending the stipe for some distance, often becoming nearly free, tubes very long; color dull olivaceous yellow (12L3), golden, or sulphur yellow when young, changing to blue where bruised in our specimens, but may be unchanging; mouths large, very irregular, more or less compound, 1–3 mm. diameter, usually the larger extreme. STIPE—*Shape*: subequal, or tapering upward in ours, but usually tapering slightly downward in other regions. *Annulus*: none. *Reticulation*: prominent, at apex, from decurrent tube dissepiments, or perhaps wholly or partially pseudo-reticulate, or rugose-reticulate, or only slightly so. *Surface*: glabrous, pruinose, minutely punctate-scabrous, or even furfuraceous, often somewhat ribbed-sulcate; color light pinkish brown (4A10), or with a mustard cast in ours, pale yellow, or often bright yellow above with superficial markings of reddish brown or brown, brown where bruised, dry. *Interior*: solid; color pinkish brown to light brown, or even yellowish white, changing slowly to faint blue. *Length*: 4–12 cm. *Diameter*: 2–3 cm. SPORES—*Color in mass*: olivaceous when fresh, yellowish brown to umber brown when older. *Shape*: elliptical to subfusiform. *Color under microscope*: pale yellow, with greenish center. *Dimensions*: 10–15 × 3.5–5 μ , mostly 11–12 × 4 μ . CYSTIDIA—*Shape*: ventricose-fusiform, occasionally clavate. *Color under microscope*: hyaline, some lemon yellow. *Dimensions*: 50–60 × 7–10 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: shrinkage is severe, but the tomentose nature of the surface of the pilei, cracking of the surface, and stipe reticulations are all well preserved.

Colors change slightly to somewhat darker. *Color of pileus*: dull, not glossy, bronze (14L9) to reddish chocolate, or chocolate brown (approximately 8H11), the cracks olivaceous golden yellow (12L6 to 12L7). *Color of the tube surface*: greenish, or dull olivaceous yellow (12L3 or 12L4). *Color of stipe*: pale olivaceous yellow (12J2).

DISTINGUISHING CHARACTERISTICS.—Although usually much smaller in eastern North America, specimens of this species were the largest boletes collected in the region. In this region specimens have a distinct mustard-colored bloom on the pilei, the general color effect being a warm, mustard-tinted khaki. Some individuals are deeply cracked, the cracks yellow and conspicuous. When making spore casts on white paper, the paper is stained yellow by the tube surface at points of contact. It is unlikely that this species will be confused with others of the same genus described here, for both *X. Zelleri* and 16. *X. sp.* have red stipes in contrast with a pinkish brown in *X. subtomentosus*, and the flesh of *X. ? pulverulentus* changes immediately to deep blue, as does that of some specimens of 16. *X. sp.* The species, however, is noted for its variability, and specimens may be collected which could prove confusing.

HABITAT NOTES.—*X. subtomentosus* was collected only twice, each time in *Thuja-Tsuga* associations which included isolated individuals of *Pinus monticola* approaching overmaturity. Although the first collection was made in 1941, the species was observed in the same location both in 1939 and 1940. The second collection was made in 1942 at a point 50 miles distant. Both *Thuja* and *Tsuga* occurred close to each collection, making it impossible to decide which was the typical associate. It has not been observed in any other association in the region. All occurrences of the species were in late fall, after the middle of October. Both collections were on banks of road cuts, and in the cleared strip between the road and the timber.

MYCORRHIZAE.—Has been reported on *Betula alba* and *Castanea sativa* in Italy (Peyronel, 1922), and its ability to form mycorrhizae on *Pinus montana* has been demonstrated experimentally (Modess, 1941).

EDIBILITY.—Reported edible by European authorities, but Peck (1889) says it is only of medium quality.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3309, 3663 (Idaho).

15. XEROCOMUS ? PULVERULENTUS (Opatowski) Gilbert

Boletus pulverulentus Opatowski

Plate 8, fig. C.

SELECTED ICONES.—Kallenbach (1926-37, pls. 6, 12); Konrad and Maublanc (1924-37, pl. 411); Michael-Schulz (1927, pl. 281); Morgan (1884, pl. 1, as *B. mutabilis*).

HABIT.—Gregarious, or sometimes caespitose. **PILEUS**—*Shape*: convex

in ours, in other regions undulated, or irregular when mature. *Diameter*: 5-9 cm., reported to 15 cm. elsewhere. *Surface*: dry, minutely, but densely tomentose, later appressed-tomentose, patchy-fibrillose, or fasciculately fibrillose, rimose-areolate, to rimose-diffract, elsewhere not rimose, glabrous and shiny in age; color olivaceous browns (15L10 to 15L7), sometimes an olivaceous khaki (14K7), the cracks considerably lighter. *Flesh*: firm; color sulphur yellow (10J1), changing to deep blue immediately when cut or broken; taste and odor of our collections not recorded, but not distinctive elsewhere. *Tubes*: adnate, very short; color deep lemon yellow (10L2), changing to deep blue immediately where bruised; mouths more or less compound, angular, unequal, 0.5-1 mm. diameter. *STIPE*—*Shape*: stout, subequal, may be thickened or tapering toward base, subsulcate. *Annulus*: none. *Reticulation*: none. *Surface*: pruinose in ours, in other regions tomentose-punctate, tomentose-scaly, or perhaps finally more or less glabrous; color deep lemon yellow (10L2), changing to blue where bruised. *Interior*: solid; color deep lemon yellow (10L2), changing to deep blue immediately when cut or broken. *Length*: to 5 cm. in ours, reaching 13 cm. elsewhere. *Diameter*: 0.6-3.5 cm. *SPORES*—*Color in mass*: dark umber brown. *Shape*: fusiform-elliptical. *Color under microscope*: yellow. *Dimensions*: 10-17 × 4-6 μ , rarely 21 × 7-8 μ , mostly 12-14 × 5-5.5 μ . *CYSTIDIA*—Numerous at the mouths, often caespitose. *Shape*: ventricose-clavate, fusiform-rostrate to subulate, often granular at the apex. *Color under microscope*: pale yellow to perhaps golden yellow. *Dimensions*: 40-77 × 5-15 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: firm specimens dry very well, the surface characters being little altered, but old, larvae-infested specimens shrink badly and may become almost black. Color of pilei usually becomes somewhat lighter, while the bright yellow tubes and stipes turn almost the same color as the pilei. *Color of pileus, tube surface, and stipe*: an olivaceous khaki (14K7), light brownish khaki (13K7) in cracks, to brownish olive drab (15L7). No trace of blue remains on dried specimens.

DISTINGUISHING CHARACTERISTICS.—This species shows the most spectacular color change of all boletes collected in the region. The bright lemon yellow of tubes and stipe changes almost immediately to deep blue where bruised in handling. It is difficult to determine the color of the interior accurately, since the change to blue occurs so rapidly following cutting or breaking. When making spore casts the tube surface stains white paper blue at points of contact, and if the stipe is immersed in water during the process, the blue leaches out, coloring the water. There is only one species among those described here with which it might be confused; 16. *X. sp.* also showing, in some individuals, a rapid change to blue, but its stipe is red, the pileus is never rimose-diffract, as are almost all specimens of *X. ? pulverulentus* collected in the region, but merely rimose-areolate.

Color of the pileus also differs, the latter being more olivaceous or greenish khaki, and closely tomentose. These two species occur in the same association, but there should be little difficulty distinguishing them.

HABITAT NOTES.—This species is not common, and has been observed only in *Thuja-Tsuga* associations which included few, scattered *Pinus monticola*. There is little doubt that *Tsuga* is the typical associate. Its best development, on the site from which three of our four collections were taken, was on a northeast-facing slope, at an elevation of 4250 feet, in an association dominated by *Tsuga* over 200 years old. Specimens were found in disturbed humus on the roadside, none being seen under the trees away from the road. The occurrence of specimens of this species only where the litter accumulation had been removed and the mineral soil disturbed to a depth of perhaps half a meter indicates the possibility that such disturbance may influence production of fruiting bodies. Several species of boletes commonly occur on such a substratum. Collections of this species have been made from the same spot both in spring and fall of the same year. Perhaps the best development is in early fall in a normal season.

MYCORRHIZAE.—No record found.

EDIBILITY.—Kallenbach (1926-37) states that he was not harmed by eating *X. pulverulentus*, but since specimens in this region are not strictly typical of the species as it is commonly known, it is perhaps advisable to avoid eating it, or at least to employ extreme caution in testing it.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2430, 2554, 2583, 2616 (Idaho).

16. XEROCOMUS sp.

Plate 5, fig. C; and Plate 8, fig. D.

HABIT.—Usually gregarious, often caespitose. PILEUS—*Shape*: convex. *Diameter*: 8-10 cm. *Surface*: glabrous, rimose-areolate, occasionally approaching rimose-diffract, dry; color dark olive brown (15L9), the cracks lighter to dingy yellowish brown (12I5), reddish, or rose-colored in some specimens. *Flesh*: firm; color lemon yellow (10K3) to pale yellowish buff (10H3), with a reddish zone beneath cuticle; color changes to deep blue almost immediately when cut or broken, making it difficult to determine the original color; taste sharply acid, or none; odor slightly acrid, or none. *Tubes*: adnexed; color bright mustard yellow (11L3) to olivaceous yellow (12L3), changing rapidly to blue where bruised; mouths irregular, 1-1.5 mm. diameter. STIPE—*Shape*: subequal. *Annulus*: none. *Reticulation*: at extreme apex only, from decurrent tube dissepiments; also a false reticulation at the base of the stipe in some individuals, consisting of a network of color, described below. *Surface*: subpruinose to pruinose, dry; color lemon yellow (10K3) at apex, dark red at base, becoming lighter toward apex, fading gradually into the yellow; the false reticulation at the base, when

present, consisting of an open network of the dark red coloration, through which the yellow color of the cortex shows. *Interior*: solid; color lemon yellow (10K3) to light golden yellow (10K5) at top, a reddish zone of varying width beneath the surface, sometimes reddish at base; color changes to deep blue immediately when cut or broken, rare individuals show no change, or the blue color appears more slowly. *Length*: 5–10 cm. *Diameter*: 1–1.5 cm. SPORES—*Color in mass*: dark umber to slightly olivaceous brown. *Shape*: elliptical, to subfusiform. *Color under microscope*: pale olivaceous. *Dimensions*: (40 only) 12–15 × 5–6 μ , mostly 13–14 × 5.5 μ . CYSTIDIA—None observed. BASIDIA—*Shape*: subglobose, to pyriform, somewhat encrusted. *Dimensions*: (10 only) 15–20 × 9–15 μ .

REMARKS.—Although this is probably an undescribed species, adequate description must await further collections and critical study.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: moderate, the surface characters being well preserved. Color becomes slightly lighter in firm specimens, darker in old, soft specimens. The red color of the stipe disappears in many specimens, but may be detected at the base in some cases on careful examination. The tube surfaces darken seriously, approaching the color of the top of the pilei, or often darker. *Color of pileus*: slightly olivaceous brown (15H9), brownish olive drab to dark olive brown (15L7 to 15L9), the cracks lighter to buff, some individuals with deep, wide cracks appearing much lighter. Rarely suffused with faint red in indefinite areas, either in the cracks only, or generally over the surface. Old, soft specimens become blackish. *Color of tube surface*: an olivaceous khaki (approximately 14L7) to dark mouse gray (16C2). *Color of stipe*: approximately suntan khaki (13L7), dull brownish khaki (14J7), or perhaps dark clove brown (16A7).

DISTINGUISHING CHARACTERISTICS.—Superficially this species looks like a rimose variant of *X. Zelleri*, but its stipe is considerably more slender, and the flesh changes to blue much more rapidly when cut or broken. It is also generally smaller. Darkening of the tubes seen in the sectioned pileus in Plate 5, figure C, is caused by the change to deep blue following cutting.

HABITAT NOTES.—This species has been collected both in the *Thuja-Tsuga* and *Picea-Abies* zones in this region. The associations in which it occurred in the *Thuja-Tsuga* zone included all the tree species characterizing the zone, but *Abies grandis* was the only tree common to all three communities. The fourth collection was found in the subalpine *Picea-Abies* climax association at an elevation of 5500 feet, in close association with *Abies lasiocarpa*. In each of the four collections species of *Abies* occurred close by, and there is little doubt that these trees are the typical associates. Collections have been made between the last of August and the third week in October. It has not been found in the spring. The specimens were growing in humus and mineral soil, and all were found on roadside

banks where there had been moderate disturbance of the substratum between 1 and 5 years prior to date of collection.

MYCORRHIZAE.—No attempt made to demonstrate mycorrhizal relationship with the typical associates.

EDIBILITY.—Not demonstrated.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2615, 3157, 3242, 3660 (Idaho).

17. XEROCOMUS sp.

Plate 8, fig. E.

HABIT.—Solitary. PILEUS—*Shape*: convex. *Diameter*: 9 cm. *Surface*: moist, subpruinose; color rose, beneath a yellowish bloom which may be rubbed off. *Flesh*: firm; color ochre yellow, changing to blue near tubes when cut; taste and odor mild, not distinctive. *Tubes*: adnexed; color ochre yellow, changing to blue where bruised; mouths rounded, 0.5–1 mm. diameter. STIPE—*Shape*: subequal. *Annulus*: none. *Reticulation*: none. *Surface*: subpruinose; color ochre yellow, with pronounced red areas. *Interior*: solid; color yellow, no color change recorded, but a change to blue is probable. *Length*: 7 cm. *Diameter*: 2 cm. SPORES—*Color in mass*: no spore cast obtained. *Shape*: subfusiform, to fusiform-elliptical. *Color under microscope*: pale olivaceous. *Dimensions*: (32 only) $13\text{--}17 \times 4.5\text{--}6\mu$, mostly $15\text{--}16 \times 5\text{--}5.5\mu$. CYSTIDIA—Rare. *Shape*: clavate, or somewhat strangulated. *Color under microscope*: brownish. *Dimensions*: (7 only) $35\text{--}50 \times 4\text{--}10\mu$, mostly $40\text{--}45 \times 6\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: severe, the pileus shrinking and twisting badly, the tube mouths closing completely. This single specimen became extremely hard when dried, in contrast to the fragility of most species. *Color of pileus*: a reddish brown (7L9), with irregular yellowish areas. *Color of tube surface*: brownish black. *Color of stipe*: yellowish tan (12K7) in a small area, the remainder of the surface black.

REMARKS.—Although this description covers but a single specimen, it appears probable that it is an undescribed species. Another large collection was carried off by squirrels while being dried in the sun, and the species has not been encountered again. Adequate description must await collection of additional material.

DISTINGUISHING CHARACTERISTICS.—This is one of two roseate-ochraceous species collected in the region, the other being *Boletinus ochraceoroseus*. Since the latter is a *Boletinus*, with the tubes in rows radiating outward from the stipe, it is readily distinguished from this species. Also, the

PLATE 5. Figure A. *Xerocomus Zelleri* (Murrill) Snell, UIFP 2614. B. *Xerocomus subtomentosus* (L. ex Fries) Quélet, UIFP 3309. C. *Xerocomus* sp. (No. 16), UIFP 3157.

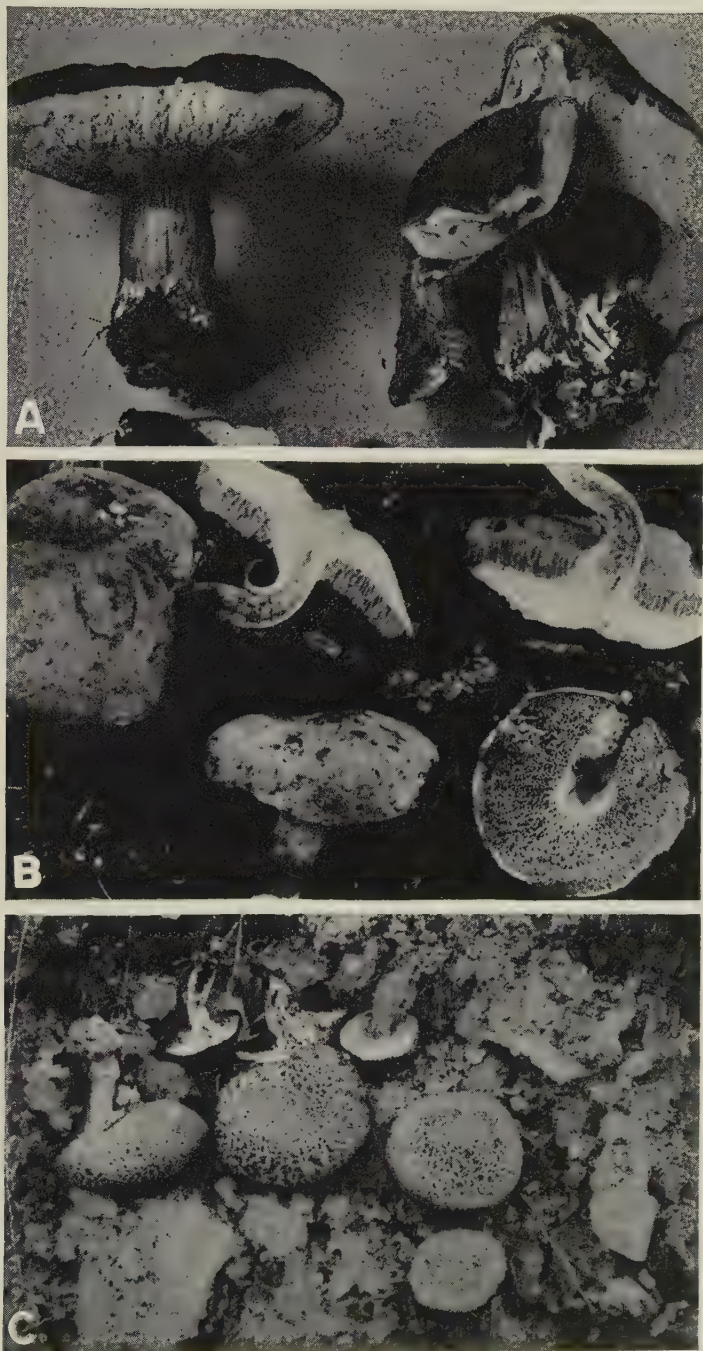


PLATE 5. (See opposite page for explanation.)

surface of the pileus of this species is smooth and subpruinose, compared to the roughly fibrillose-scaly surface of *Bol. ochraceoroseus*.

HABITAT NOTES.—Both collections occurred in climax *Thuja-Tsuga* associations, in proximity to both *Thuja* and *Tsuga*. The collections were made in the spring, no specimens being observed in the fall.

MYCORRHIZAE.—Not demonstrated.

EDIBILITY.—Not demonstrated.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2429 (Idaho).

- II. Stipe truly reticulate from apex to below center, excluding those reticulate only at apex above an annulus; or if not, then tube mouths red, or tubes stuffed when young.

BOLETUS Dillenius ex Fries

Fruiting body rather stout and robust; tubes simple; stipe stout and more or less bulbous, especially at first; spores subfusiform.

1. Tubes and mouths of the same color..... 2
Tubes and mouths differently colored, mouths some shade of red. (None collected in the region.)
..... Section LURIDI
2. Tubes free or adnate; if the latter, then stuffed when young..... Section EDALES..... 3
Tubes adnate, not stuffed when young..... Section CALOPODES..... 4
3. Tubes white at first, then greenish yellow; pileus khaki, glabrous; stipe light yellow brown; color of flesh unchanging..... 18. *B. edulis*
Tubes lemon yellow to greenish yellow; pileus brown, slightly olivaceous, subtomentose; stipe lemon yellow, turning brown where bruised; color of flesh changing to blue where cut or broken, taste bitter..... 19. *B. fragrans*
4. Pileus dark chocolate brown, tomentose to fibrillose-scaly; stipe brownish red to dark crimson, bulbous..... 20. *B. mirabilis*
Pileus buff to sand brown, closely canescent, deeply rimose-diffract, at least in part; tubes very short, mouths very small; a large species..... 21. *B. frustuosus*

18. BOLETUS EDULIS Buillard ex Fries

Plate 8, fig. F.

SELECTED ICONES.—Peck (1897, pl. 36; 1898, pl. 54; 1900, pl. 65); Atkinson (1903, pl. 55, fig. 2; pl. 56, fig. 164; pl. 57, fig. 165); Clements (1910, fig. 54); Hard (1908, figs. 286, 290); Gibson (1895, pl. 20); Bresadola (1931, pl. 923); Michael-Schulz (1927, pl. 93); Macku (1925, fig. 132); Jacottet (1925, pl. 61).

HABIT.—Solitary, or gregarious. PILEUS—*Shape*: convex, or nearly plane. *Diameter*: 7–22 cm. *Surface*: moist, viscid at times, sometimes very slimy when wet, glabrous; color variable, khaki, grayish red, brownish red, tawny brown, or pale ochraceous, often paler on the margin. *Flesh*: at first firm and compact, later sometimes soft; color white, or yellowish white, perhaps pinkish occasionally, may be reddish under the cuticle and next the tubes; taste sweet and nutty; odor not distinctive, strongly fungous, or nutty. *Tubes*: adnexed to nearly free; color white when young,

later yellow with a greenish tinge, becoming more or less ochraceous where bruised; mouths nearly circular, small to minute. STIPE—*Shape*: subequal, or bulbous, straight, or flexuous, stout. *Annulus*: none. *Reticulation*: more or less whitish-reticulate almost full length, but especially above, sometimes becoming almost rugose toward base. *Surface*: glabrous, pruinose, or possibly white-tomentose at very base; color whitish pallid, light yellowish, to light brownish. *Interior*: solid; color pure white to reddish, or more or less streaked reddish. *Length*: 5–22 cm. *Diameter*: 1.2–3.6 cm., to 5.5 cm. at base. SPORES—*Color in mass*: deep olivaceous brown, becoming deep ochraceous brown. *Shape*: fusiform-elliptical. *Color under microscope*: pale olivaceous. *Dimensions*: 12–18 \times 4–6 μ , mostly 14–16 \times 5 μ . CYSTIDIA—Not abundant. *Shape*: ventricose-subulate to ventricose-rostrate. *Color under microscope*: hyaline. *Dimensions*: 50–60 \times 7–10 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: the single collection shrank severely, losing over 75% in volume. The pilei wrinkled badly, but reticulation on the stipe remained clearly visible over the apical one-third of its length. The pilei lightened considerably in color, but the stipe darkened to a light yellowish brown. No color references were determined.

DISTINGUISHING CHARACTERISTICS.—The flesh of this species shows no color change on cutting, but in *B. fragrans*, the only species collected with which it can be confused, the flesh changes to blue. The stipe is prominently reticulate to the ground line in this collection, the pileus khaki; tube surface white.

HABITAT NOTES.—This species was collected in a climax *Thuja-Tsuga* association. On the basis of a single collection, no conclusion could be reached regarding the typical associate, although it is reported in the east under *Tsuga* and hardwood mixtures. Other western reports indicate that it is also associated with firs (*Abies* spp. ?) and *Picea*. The collection was made in mid-August.

MYCORRHIZAE.—Reported forming mycorrhizae on *Larix* in Sweden (Rayner, 1927). Its ability as a mycorrhizae-former on *Betula* was demonstrated experimentally by Melin (1923b).

EDIBILITY.—*B. edulis* is one of the best of all edible fungi. Highly prized by European mycophagists, it was known to the Romans.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3206 (Wash.).

19. BOLETUS FRAGRANS Vittadini

Plate 8, fig. G.

SELECTED ICONES.—Bresadola (1931, pl. 926); Soc. Myc. Fr. (1931, Atlas plate 45).

HABIT.—Often caespitose. PILEUS—*Shape*: convex. *Diameter*: 3–10 cm. *Surface*: dry, subtomentose, then glabrescent, finally rimose-areolate;

color a deep, bright brown, perhaps olivaceous brown, pallid brown, or even bronze. *Flesh*: firm, very thick; color yellow, or yellowish white, or perhaps whitish, usually changing to blue when cut, but perhaps unchanging; taste at first bitter, then pleasant; odor fragrant, or not distinctive. *Tubes*: adnate and depressed, or almost free; color lemon yellow, then cinereous-olivaceous, changing to blue on injury; mouths small, 0.25–0.33 mm. diameter, rotund to sinuate. *STIPE*—*Shape*: stout, short, ventricose, usually tapering at the base, later extending, even. *Annulus*: none. *Reticulation*: almost full length, conspicuous in our collection, but usually regarded as not reticulate, or only very slightly so. *Surface*: glabrous above, slightly viscid, tomentose to pubescent at base only; color lemon yellow above, below yellow tinged reddish, pinkish, olivaceous, or brownish, the base quite brown, sometimes more pallid all over, the lighter colors changing to rosy where bruised. *Interior*: solid; color like flesh of pileus, perhaps more yellowish at base, often with a reddish line of demarcation between flesh of stipe and that of pileus, changing to blue when cut. *Length*: 4–8 cm. *Diameter*: 2.5–5 cm. at base. *SPORES*—*Shape*: subfusiform. *Color under microscope*: pale yellow to pale olive. *Dimensions*: 10–15 × 4.5–5.5 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: severe, the pileus of this single specimen shrinking and wrinkling badly. Despite shrinkage, surface texture, and even color, were well preserved. Color of the tube surface turned grayish brown. The stipe wrinkled extensively and turned dark brown with black areas, the reticulation being completely lost. No color references were determined for this single collection.

DISTINGUISHING CHARACTERISTICS.—Likely to be confused only with *B. edulis*, this species has a bitter taste when young, yellow tubes turning blue where bruised, as does the flesh when cut, while *B. edulis* has a pleasant taste, or at least not bitter, white or greenish white tubes which do not turn blue, and the flesh does not turn blue.

HABITAT NOTES.—The single collection of this species was found in a closely subclimax association of *Thuja-Tsuga*. It was growing in the duff layer at the immediate base of a small *Tsuga* and was collected in early August.

MYCORRHIZAE.—No record found.

EDIBILITY.—Reported edible by European authorities.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2546 (Idaho).

20. BOLETUS MIRABILIS Murrill

Ceratomyces mirabilis Murrill

Plate 6, figs. A and B; and Plate 8, fig. H.

SELECTED ICONES.—Overholts (1940, figs. 13, 14). The only plate published of this species. Not typical of collections from this region.

HABIT.—Usually solitary, may be gregarious, or rarely caespitose. **PILEUS**—*Shape*: convex, very rarely upturned. *Margin*: often partially appendiculate with a sterile, incurved flap, 1–3 mm. wide, which is yellow on the extreme edge and underneath, in the young plant connecting with the outer layer of the stipe. *Diameter*: 5–16 cm. *Surface*: dry, sometimes moist, closely tomentose to fibrillose-scaly on parts of the pileus, resembling rather coarse, suede-type leather, the fibrillose scales often in the form of projecting, conic, floccose to fibrillose points about the center of the pileus; color dark reddish chocolate brown (8J3), occasionally somewhat lighter, particularly when old. *Flesh*: firm; color reddish brown, darkest under cuticle, paler toward stipe, may be lemon yellow when young, slowly changing to incarnate, or perhaps more reddish when cut or bruised; taste mild, not distinctive; odor slightly acid. *Tubes*: adnexed, often narrowly depressed, very long; color bright sulphur yellow (9K1), dulling with age to pale mustard yellow (11L2), no color change immediately upon injury, but bruised areas turn deep mustard yellow after some hours; mouths subcircular to irregularly angular, 0.75–1 mm. diameter. **STIPE**—*Shape*: tapering upward strongly, subbulbous to bulbous, usually stout and often abruptly narrowed at base. *Annulus*: none. *Reticulation*: near apex, shallowly lacunate to rugose to base, the depressions vertically elongated and perhaps to be considered downward extension of reticulation. *Surface*: glabrous, with a silvery hoariness, particularly toward base, which has been considered remnants of a universal veil; color reddish brown to dull garnet red (7L8 to 7J5), or maroon, silvery pink in the lacunate depressions, giving the stipe a striking appearance, the extreme base sometimes white. *Interior*: solid; color white, golden yellow at base, becoming more or less reddish in age. *Length*: 12–20 cm. *Diameter*: 1–3.5 cm. at apex, 4–8 cm. at base. **SPORES**—*Color in mass*: olive brown. *Shape*: ventricose-subfusiform. *Color under microscope*: wall with a reddish tinge, contents deep olivaceous yellow. *Dimensions*: 14–24 × 6.5–9 μ , mostly 21–24 μ long. **CYSTIDIA**—Usually fairly abundant, sometimes scarce. *Shape*: ventricose-rostrate, the apex obtuse. *Color under microscope*: hyaline. *Dimensions*: 50–90 × 8–24 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: Murril (1912, p. 98) states "it is one of the most difficult species to preserve, owing to its extremely juicy consistency." Although shrinking perhaps 65% in volume, these specimens dried perhaps the best of all species of the family collected. Surface characters are excellently preserved, except for the stipes, which wrinkled until the shallow depressions were lost. Color of the pilei changed but little, the tubes darkened somewhat, but less so than in most species. Color of stipes showed the greatest change, some becoming lighter, others darker. *Color of pileus*: vandyke brown (7A11), to chocolate brown (8H10). *Color of tube surface*: golden olivaceous yellow (12L6) to dark olivaceous yellow (13L6), usually dulled by the chocolate brown of

the tube walls, which show through the wide tube mouths. *Color of stipe*: light suntan khaki (13J7) with narrow reddish or brown streaks, dull brown (8E4) with black streaks to almost black.

DISTINGUISHING CHARACTERISTICS.—This chocolate brown species, with the feel and appearance of soft, rather coarse, suede-type leather, is unique in the region. The stipe, in all but rare specimens, tapers upward strongly from a somewhat bulbous base, the apex frequently measuring less than one-fifth the diameter of the base. No other species found exhibits such extreme taper in the stipe. The most beautiful bolete in the region. The upturned margin of the specimen pictured in Plate 6, figure B, is somewhat unusual.

HABITAT NOTES.—*Boletus mirabilis* has been observed only in climax *Thuja-Tsuga* associations. It is almost impossible to conclude whether *Thuja* or *Tsuga* is the typical associate, since climax stands in this region usually exhibit such uniform intermixtures that all specimens observed were near trees of both species. All but rare individuals were growing in windfalls which were in a condition of advanced decay, as the specimen shown in Plate 6, figure A. Such windfalls were usually more than half buried in the litter accumulation, the wood being extremely friable and usually having tree, or other plant roots growing through it. In several instances such roots were found immediately adjacent to the mass of white mycelium at the base of the stipes. No effort was made to trace these roots, or to identify them. This is the only bolete collected growing primarily in wood. It has not been observed in the spring, but is common in many climax forest areas in the fall, after the forest floor becomes saturated by fall rains. One collection was made on July 28. Optimum development is usually between late September and early November. Apparently a favorite food of rodents, the fruiting bodies are frequently partly eaten and none are left long enough to become decayed.

MYCORRHIZAE.—No record found.

EDIBILITY.—No record found.

COLLECTIONS.—U. of Idaho For. Path. Herb. 2633, 3158 (Wash.). The species was also observed on the Priest River Experimental Forest in Idaho.

21. BOLETUS FRUSTOSUS Snell and Dick

Plate 8, fig. J.

SELECTED ICONES.—None published.

HABIT.—Gregarious. **PILEUS**—*Shape*: convex. *Diameter*: 7–25 cm. *Surface*: dry, scarcely submentose, or closely canescent, deeply rimose-diffract, broken into large frusta, or rarely only rimose-areolate; color yellowish buff to honey-colored (12J6), or grayish brown. *Flesh*: firm to

solid; color whitish, whitish yellow, or pale sand brown, unchanging; taste very bitter; odor somewhat soapy. *Tubes*: adnate, separating; very short; color yellow to greenish yellow, or dull sand brown, readily changing to blue where bruised, drying with a more or less reddish cast; mouths yellow, almost circular, very small to medium, 0.1–1.5 mm., usually 0.1–0.5 mm. diameter. *STIPE*—*Shape*: very thick, subcylindric, or ventricose, usually with a fusiform base. *Annulus*: none. *Reticulation*: most of length, the reticulations fine, subrotund. *Surface*: dry, pruinose-furfuraceous, to almost subtomentose above, often punctate-furfuraceous, glabrescent below, often fibrillose cracked; color yellowish buff to honey-colored (12J6), tinged red at the apex, cracks yellow where present. *Interior*: solid; color whitish to whitish yellow, red at the base, tinged red throughout, changing to blue only in the center. *Length*: 3–13 cm. *Diameter*: 4–9 cm. *SPORES*—*Color in mass*: ochraceous brown. *Shape*: subfusiform, mostly narrowed at the distal end, to almost pointed. *Color under microscope*: pale greenish yellow. *Dimensions*: 11–15 × 4–5.5 μ , very rarely 16 × 6 μ or longer, mostly 13–14 × 4.5–5 μ . *CYSTIDIA*—Single on the walls, or clustered at the mouths. *Shape*: clavate, fusiform, or ventricose-rostrate. *Color under microscope*: hyaline, or colored. *Dimensions*: 25–35 × 8–12 μ .

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: this species dries very hard, not fragile, with moderate shrinkage and little surface distortion. Texture and the rimose-diffract character of the pileus are perfectly preserved. Color changes little in many specimens, but in others, notably those which were old or larva-infested when collected, certain areas turn dark brown. Stipes are not seriously distorted, the surface characters being fairly well preserved. *Color of pileus*: dull buff, or honey-colored (12J6), or slightly lighter, often with blackish brown areas. *Color of tube surface*: light suntan khaki (13J7) to a dull umber brown (15E10). *Color of stipe*: like pileus.

DISTINGUISHING CHARACTERISTICS.—*B. frustosus* is a large species, buff, or light sand brown in color, with the pileus surface commonly deeply rimose-diffract, broken into large, subpyramidal frusta. Flesh of the pileus has an extremely bitter taste in contrast to the mild taste of *Xerocomus subtomentosus*, the only species in this region likely to be confused with it. The tube mouths are abnormally small for such a large species, seldom exceeding 0.5 mm.

HABITAT NOTES.—The single collection of this species was made by R. T. Bingham on Sands Creek, Coeur d'Alene National Forest, Kootenai County, Idaho, late in July. The specimens occurred in a climax stand of *Tsuga heterophylla* over 200 years old. This site is about 75 miles south of the region in which the study was conducted, but still well within the inland extension of the *Thuja-Tsuga* zone. Here, however, the climax association rarely includes *Thuja*.

MYCORRHIZAE.—Not demonstrated.

EDIBILITY.—Not demonstrated.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3156 (Idaho).

- III. Stipe scabrous, or at least squamulose, tapering; tubes white, at least at first, not stuffed when young; spores more or less broadly fusiform-elliptical.

LECCINUM S. F. Gray

Tubes white, at least at first, free, or adnate, stuffed when young if the latter; stipe more or less slender and scabrous, tapering upwards; spores more or less broadly fusiform.

1. Color of stipe surface changing to blue where bruised, at least at base; pileus yellowish orange, orange yellow, or somewhat reddish brown, glabrous, viscid..... 22. *L. versipelle*
Color of stipe surface unchanging where bruised, or at least not changing to blue; pileus variable, warm brownish chamois to dull walnut brown, or grayish brown, glabrous, dry.....
..... 23. *L. scabrum*

22. *Leccinum versipelle* (Fries *apud* Hök) Snell, comb. nov.

Boletus versipellis Fries *apud* Hök⁷

Plate 8, fig. K.

SELECTED ICONES.—Peck (1897, pl. 34); Michael-Schulz (1927, pl. 94); Bresadola (1931, pl. 935, as *B. rufus*); Hard (1908, fig. 295); Macku (1925, fig. 125); Konrad and Maublanc (1924-37, pl. 408); Clements (1910, fig. 55).

HABIT.—Solitary. PILEUS—*Shape*: convex. *Margin*: appendiculate with the projecting cuticle. *Diameter*: 4-21 cm. *Surface*: usually dry, subviscid when moist, at first compactly and minutely tomentose, then fibrillose-squamulose to fibrillose, occasionally fibrillose-granulose, or rarely glabrous; color mostly dull orange yellow, but also grayish brown to ochraceous brown, or even somewhat orange, our single collection slightly reddish brown. *Flesh*: very firm to somewhat soft; color white or whitish, then more or less roseate, becoming more or less violaceous-roseate and then

⁷ It is perhaps advisable to note that the specific epithet here employed for this species is not widely accepted. It has been called *Boletus rufescens* Secretan, and *Krombholzia floccopoda* (Rostk.) Gilbert. There is a distinct possibility that it may prove to be *Leccinum aurantiacum* (Bull. ex Roques) S. F. Gray (= *B. rufus* Schaeffer ex Fries), in which case *L. aurantiacum* would have priority.

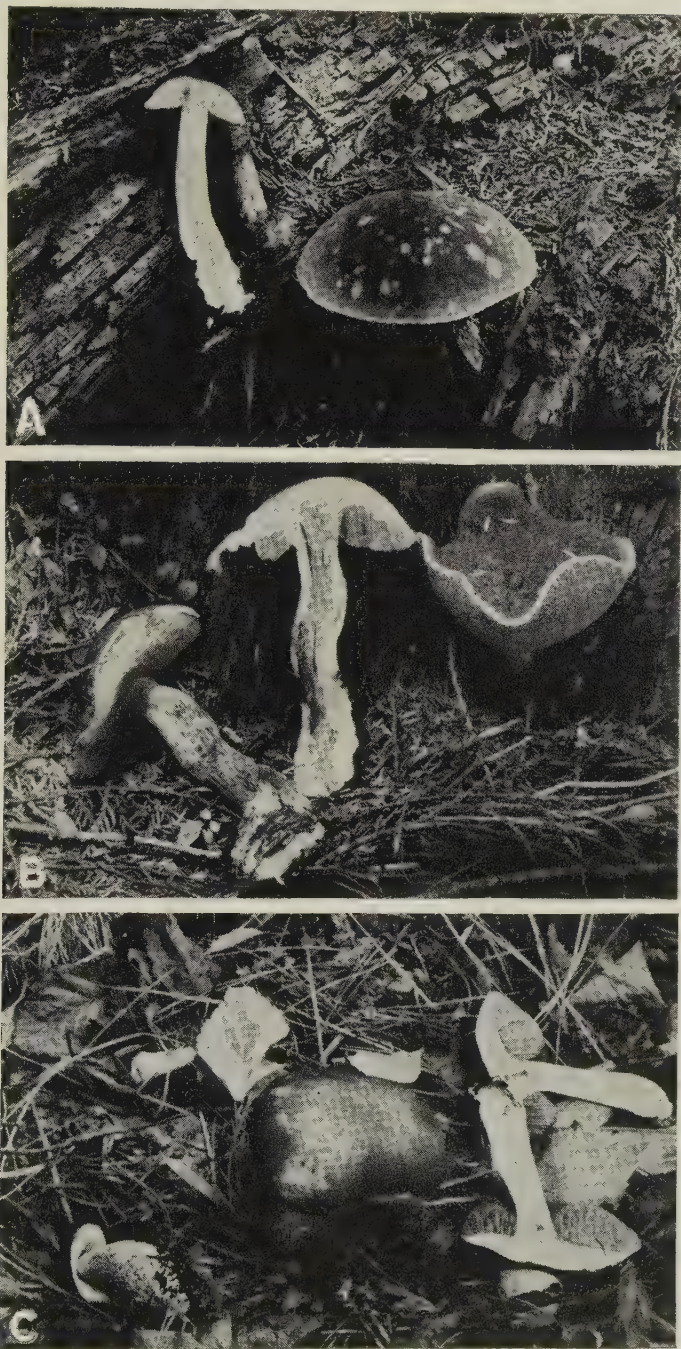


PLATE 6. (See opposite page for explanation.)

gray or blue at edges when cut or bruised; taste and odor mild, not distinctive. *Tubes*: adnate, adnexed, becoming free or nearly so, depressed-concave, or plane; very long; color dirty white to gray; mouths rotund to irregularly circular, small, to 0.75 mm. diameter. *STIPE*—*Shape*: slender, more or less bulbous, tapering upward. *Annulus*: none. *Reticulation*: none, or more or less pseudo-reticulate or rugose-reticulate. *Surface*: somewhat viscid when wet, scabrous to squamulose, fairly densely so toward apex, or more or less rugose to sulcate from splitting of the cortex; color dirty white, the projections or squamules brown or brownish cinereous below, variously stained, changing to greenish blue at base when bruised. *Interior*: solid; color white to dingy, becoming more or less roseate to violaceous-roseate at base, often more or less yellow, becoming lightly tinged or spotted with blue or green at base when bruised, or perhaps changing to greenish blue at edges only. *Length*: 5–20 cm. *Diameter*: 1–5 cm. *SPORES*—*Color in mass*: snuff brown. *Shape*: narrowly elliptic-fusiform to quite fusiform. *Color under microscope*: pale greenish or olivaceous. *Dimensions*: $11-17 \times 3.5-5\mu$, mostly $14 \times 4-4.5$ or possibly 5μ . *CYSTIDIA*—Rare to abundant. *Shape*: fusiform-ventricose, fusiform-clavate, apiculate, or ventricose-rostrate with long beaks, and all intergradations in form. *Color under microscope*: hyaline. *Dimensions*: $35-50 \times 7-10\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: moderate. Pileus of the single specimen shrank approximately 40%, the surface wrinkled somewhat, but not seriously. Color darkened, but relatively little. The stipe shrank considerably in diameter, little in length. Its color changed to pale yellow at the base and dirty brown above. The scabrous nature of the stipe remained conspicuous. No color references were determined for this single collection.

DISTINGUISHING CHARACTERISTICS.—This species closely resembles *L. scabrum*, but its appendiculate margin serves to distinguish it from that species in most cases. It is also predominantly yellow orange or orange yellow, although sometimes brown or white. *L. scabrum* never shows the orange colors, and only rarely is at all yellowish. The flesh of the stipe and pileus usually changes to greenish blue when cut or broken, in spotty, restricted areas, as does the outside of the stipe where bruised. *L. scabrum* shows no color change.

HABITAT NOTES.—*L. versipelle* is reported occurring in association with species of *Populus* in other regions. Unfortunately, no record was made of the association in which this single collection was found. It was collected on August 31.

MYCORRHIZAE.—No record found.

EDIBILITY.—Peck (1889) reports *L. versipelle* edible, "but scarcely to be commended."

COLLECTIONS.—U. of Idaho For. Path. Herb. 3227 (Idaho).

23. *LECCINUM SCABRUM* (Bulliard ex Fries) S. F. Gray*Boletus scaber* Bulliard ex Fries

Plate 6, fig. C; and Plate 8, fig. L.

SELECTED ICONES.—Peck (1897, pl. 35); Michael-Schulz (1927, pl. 95); Hard (1908, fig. 282); Gibson (1895, pl. 21); Bresadola (1931, pl. 936); Murrill (1909, pl. 1, fig. 5); Marshall (1905, pl. 46, p. 108); Güssow and Odell (1927, pl. 96); Murrill (1916, fig. 2); Migula (1925, pl. 42D); Jaccottet (1925, pl. 63); Macku (1925, fig. 123).

HABIT.—Solitary to gregarious. PILEUS—*Shape*: convex, hemispherical, or even subconical. *Margin*: not appendiculate with an overhanging cuticle. *Diameter*: 5–21 cm. *Surface*: glabrous, to sparsely and minutely fibrillose, slightly to very viscid when moist, often completely dry, at length perhaps rugulose or rivulose, sometimes rimose-areolate, particularly where exposed to full sun; color extremely variable, from warm brownish chamois (11H5) to dark sepia brown (8A10), or grayish walnut brown (8E7), in other regions reported possibly whitish, or very rarely even yellowish. *Flesh*: firm; color white, hardly changing when young, when older becoming grayish on exposure to the air, or perhaps pinkish, or violaceous brownish in places; taste mild; odor not distinctive. *Tubes*: adnexed to almost free, depressed; very long; color dull white to chamois (11J5), becoming flesh color or blackish where bruised, brownish with age; mouths rotund to slightly irregular, 0.4–2 mm., usually 0.4–1 mm. diameter. STIPE—*Shape*: tapering upward, often sharply so, subbulbous. *Annulus*: none. *Reticulation*: none. *Surface*: fibrillose-scaly, or more commonly scabrous, more or less costate or pseudo-reticulate, at least toward base, dry; color dirty white to ivory, the scales gray, or brown. *Interior*: solid, tough, and very fibrous; color white, becoming grayish, sometimes changing to a definite dull rose when cut or broken, or may show no color change, often greenish at base. *Length*: 5–15 cm. *Diameter*: 2–5 cm. at base. SPORES—*Color in mass*: coffee brown, or snuff brown. *Shape*: fusiform-elliptical. *Color under microscope*: olivaceous brown. *Dimensions*: 13–21 × 4–7 μ , occasionally to 35 × 9 μ , mostly 16–18 × 4–6 μ . CYSTIDIA—Lacking, or rare. *Shape*: clavate, to ventricose-rostrate. *Color under microscope*: hyaline. *Dimensions*: 25–60 × 7–10 μ .

A single aborted specimen, with tube surface extending down the stipe to the ground, forming an almost cylindrical fruiting body (UIFP 3263), was found in 1941. The tube mouths were large, to 2.0 mm., extremely irregular, the openings frequently compound and of a dark sand brown color. The pileus was light umber brown. This specimen was old and had begun to putrefy, the colors being undoubtedly considerably degraded.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion*: moderate, the surface usually wrinkling considerably less than in most species. The pilei, however, often become somewhat contorted. The scabrous nature of the stipe surface is usually well preserved. *Color of pileus*:

shades of dull buff (approx. 12H6) to dark brown (16C10). *Color of tube surface*: dark coffee brown (8H12) to darker, blackish brown. *Color of stipe*: shades of dull buff and light grayish brown (12F5 to 14H8) to light coffee brown (15A11).

DISTINGUISHING CHARACTERISTICS.—*Leccinum scabrum* is an extremely variable species, the most constant character being its scabrous, white stipe. *L. versipelle* has a closely similar stipe, but its surface usually turns to greenish blue where bruised, in spotty, restricted areas, as does flesh of both stipe and pileus. The former shows no color change on the stipe surface, or at most turns somewhat darker. Margin of the pileus is not appendiculate in *L. scabrum*.

HABITAT NOTES.—The four collections of this species were made in 21–40 year associations consisting of a mixture of most of the seral tree species occurring in the *Thuja-Tsuga* zone. The typical associate is *Betula*, as in other regions. One collection was made in early July, but the best development occurs in September and early October in a normal season.

MYCORRHIZAE.—Peyronel (1922) believes that this species may change form according to the tree species with which it occurs in mycorrhizal association, the forms differing in size of pileus, color, and diameter of the stipe. It has been reported forming mycorrhizae on *Betula alba* in Sweden and Russia (Rayner, 1927), *Corylus avellana* and *Quercus robur* in Italy (Peyronel, 1922), and *Populus tremula* in Italy (Peyronel, 1922) and Sweden (Melin, 1923b). There is reason to believe that the fungus forming mycorrhizae on the latter species is not a form of *L. scabrum*, as Peyronel believes possible, but is a distinct species, *Boletus rufus* Schaeffer ex Fries [*B. aurantiacus* Bulliard ex Rocques, or *Leccinum aurantiacum* (Bulliard ex Rocques) S. F. Gray, according to Snell's (1941, 1942) conception of the genera]. Mycorrhizae were formed experimentally by *L. scabrum* on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940).

EDIBILITY.—Several authorities agree that the species is edible.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3153, 3250, 3263, 3364 (Idaho).

PLATES 7 and 8. Spore photomicrographs, showing portions of fields photographed through a Whipple eyepiece micrometer. Each of the five small graduations along the upper left margin of each figure measures approximately 5.2 μ . All figures 910 \times .

PLATE 7. Figure A. *Boletinus cavipes* (Opatowski) Kalchbrenner. UIFP 2584. B. *Boletinus amabilis* (Peck) Snell. UIFP 3045. C. *Boletinus ochraceoroseus* Snell. UIFP 3085. D. *Boletinus* ? *appendiculatus* Peck. UIFP 3086. E. *Suillus hirtellus* (Peck) Snell, var. *mutans* Peck *apud* Snell. UIFP 3252. F. *Suillus aeruginascens* (Secretan) Snell. UIFP 3047. G. *Suillus elegans* (Fries) Snell. UIFP 3084. H. *Suillus* ? *subaureus* (Peck) Snell. UIFP 3261. J. *Suillus granulatus* (L. ex Fries) Snell. UIFP 2570. K. *Suillus subluteus* (Peck) Snell. UIFP 2572. L. *Suillus luteus* (L. ex Fries) Snell. UIFP 3050. M. *Suillus americanus* (Peck) Snell. UIFP 2578.

PLATE 8. Figure A. *Xerocomus Zelleri* (Murrill) Snell. UIFP 2614. B. *Xerocomus subtomentosus* (L. ex Fries) Quélet. UIFP 3063. C. *Xerocomus* ? *pulverulentus* (Opatowski) Gilbert. UIFP 2583. D. *Xerocomus* sp. (No. 16). UIFP 2615. E. *Xerocomus* sp. (No. 17). UIFP 2429. F. *Boletus edulis* Bulliard ex Fries. UIFP 3206. G. *Boletus fragrans* Vittadini. UIFP 2546. H. *Boletus mirabilis* Murrill. UIFP 2633. J. *Boletus frustosus* Snell and Dick. UIFP 3156. K. *Leccinum versipelle* (Fries *apud* Hök) Snell. UIFP 3227. L. *Leccinum scabrum* (Bulliard ex Fries) S. F. Gray. UIFP 3250.

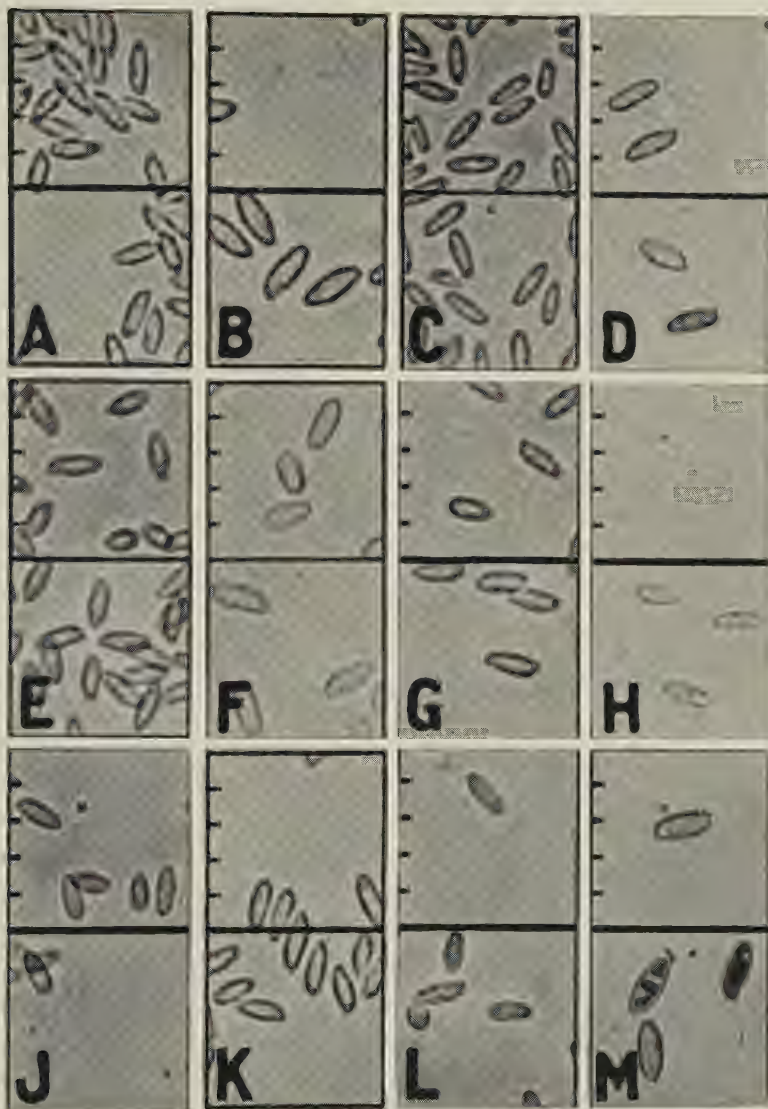


PLATE 7. (See opposite page for explanation.)



PLATE 8. (See page 62 for explanation.)

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New or Noteworthy Tropical Fungi. III

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***Pseudovalsa tropicalis* Wehmeyer, sp. nov.**

Figs. 1-3

Stromatibus corticulis tectis, dein erumpentibus, angularibus, nigro-brunneis vel nigris, 1-2 mm. diam., peridermatibus circumdatis; ostiolis cylindraceo-conicis, interdum recurvatis; peritheciis dispersis, saepe polystichis in stromatibus; ascis cylindraceis, parietibus crassis, $200-250 \times 27-32\mu$; paraphysisibus latis taeniformibus, fugaceis; sporidiis monostichis, latis elliptico-fusoideis, hyalinis, didymis, dein obscure 5-7-septatis, media parte constrictis, $55-62 \times 19-22\mu$. Status conidiophorus *Corynei* sp. sistit; conidiis in superficie stromatum, elliptico-fusoideis vel cylindraceo-fusoideis, atro-brunneis, 6-11-septatis, $45-135 \times 18-22\mu$.

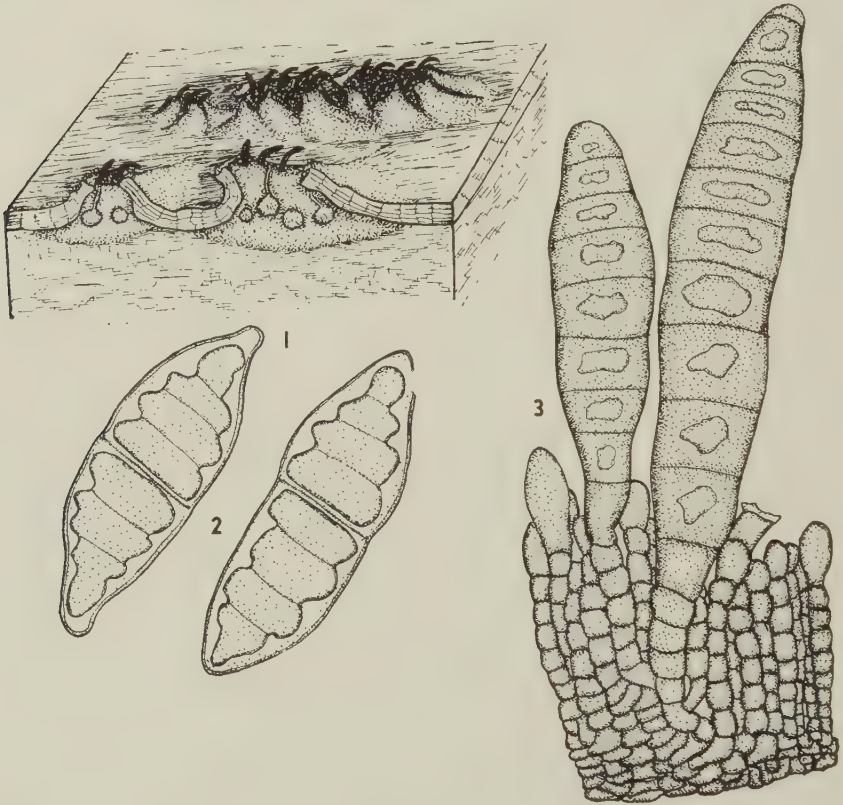
Appearing on the surface as scattered to longitudinally seriate, angular, erumpent, black-brown to black, roughened, stromatic discs, 1-2 mm. in diameter, with a collar of adherent periderm; ostioles cylindric-conic, with a tapered apex, sometimes slightly elongate, often recurved, scattered over the surface of the disc; stromata gray-black, sharp-margined, pulvinate, originating in the upper bark cortex and erumpent through the thick periderm as the widely erumpent discs, composed of brown-walled fungous pseudoparenchyma; perithecia $600-800 \times 400-500\mu$, irregularly scattered, often polystichous, immersed in the stroma, with long narrow emergent necks; asci cylindric-clavate, thick-walled, $200-250 \times 27-32\mu$; paraphyses, apparently, broad, band-like, evanescent; spores obliquely uniseriate, broad fusoid-ellipsoid, hyaline, with a definite central septum and 4-6 secondary septa consisting of a mere division of the protoplast or fine extensions of the thickened gelatinous inner layer of the outer wall, hence eventually 6-8-celled, usually constricted at the central septum, with an irregularly thickened inner wall layer, $55-62 \times 19-22\mu$.

Conidial stage a *Coryneum*. Conidia borne on the surface of the perithecial stromata as terminal developments of the chains of parenchymatoid cells of the stroma; fusoid-ellipsoid to cylindric-fusoid, somewhat tapered toward the basal stalk cell and the more blunt apical cell, which is often lighter in color; dark brown, 7-12-celled, not constricted at the septa, $45-135 \times 18-22\mu$.

PANAMÁ: Prov. Chiriquí. Valley of upper Rio Chiriquí Viejo, 1600-1800 m., July 3, 1935, G. W. M. 2416, Type. On bark of large prostrate trunk.

This species has the characteristic well-defined, sharp-margined stroma, with no sharp distinctions between ecto- and ento-stroma, of the genus

Pseudovalsa. The spores are of the same type as in *P. lanciformis* and *P. umbonata*, but are of a more primitive aspect, remaining hyaline and having thickened inner walls and poorly developed septa in the two primary cells. The necks are also more elongate than in the two species mentioned.



FIGS. 1-3. *Pseudovalsa tropicalis*. 1. Radial and surface views of perithecial stroma, enlarged. 2. Ascospores, $\times 750$. 3. Detail of surface of conidial stroma, showing conidia and their attachment, $\times 750$. Drawn by Dr. L. E. Wehmeyer.

SEBACINA MUCEDINEA Pat.

Fig. 4

Originally described from Ecuador (Bull. Herb. Boiss. 3: 60. 1895) on the basis of a collection by Lagerheim, this species seems not to have been recorded since. To it I refer, with some reservation, two collections from Panamá. One, C. W. Dodge, 3928, August 3, 1925, is from Barro Colorado Island on dead cane of bamboo. The other, G. W. M. 2018, was collected in Balboa at the foot of Ancon Hill on a decorticate branch, in June, 1935.

Patouillard's diagnosis is reproduced with slight change in the *Sylogae Fungorum* 14: 214, where the species is referred to *Thelephora*. The distinctive characters are the thin, almost arid fructification, the pallid color



FIG. 4. *Sebacina mucedinea*. The basidium and two spores at the right are from G. W. M. 2018; the others are from C. W. Dodge 3928, $\times 1000$. FIG. 5. *Sebacina obscura*. Basidia and spores, showing characteristic truncate appearance of probasidia. Type, $\times 1000$. FIG. 6. *Pellicularia biapiculata*. Basidia, hyphal segment with plugged septa and basidiospores. Type, $\times 833$. FIG. 7. *Stereum cyphelloides*. Basidium, two smooth and five rough spores, $\times 1000$. FIG. 8. *Stereum radicans*. Three smooth and two rough spores, $\times 1000$. FIG. 9. *Peniophora gemmea*. Basidia and basidiospores. Type, $\times 833$. FIG. 10. *Pellicularia digitata*. Basidium, basidiospores and cystidium. Type, $\times 833$. FIG. 11. *Cymatella longipes*. Type. Habit, $\times 4$; basidiospores, $\times 1000$. Figures 6, 9 and 10 are based on camera lucida drawings by Mrs. D. P. Rogers.

and pruinose surface and the curved, cylindrical spores produced on cruciate-septate basidia. Patouillard notes that the species is close to *S. Letendreana* Pat., which Bourdot and Galzin (Hymén. France 45. 1928) regard as a form of *S. calcea*. Through the kindness of Dr. D. H. Linder, I have been permitted to examine the type of *S. mucedinea*, now in the Farlow Herbarium. It is very scanty, consisting of a few fragments of a

decayed twig on which the *Sebacina* appears in the form of dingy white to pale pinkish arachnoid patches, in some places thicker and then more pruinose. The hyphae bear obscure clamp-connections. The spore-size given in the original description is $10 \times 5 \mu$. The few spores seen in the two mounts I ventured to make were somewhat longer and narrower, $10.5-11.2 \times 3.5-4.2 \mu$. Dr. Rogers, who has also examined the type, found some as large as $13 \times 5 \mu$. The two collections from the Canal Zone agree essentially in all respects except that neither shows any dense, pruinose areas. The Barro Colorado collection is rather conspicuous against its dark, polished substratum. The Balboa collection is much more tenuous and scarcely visible. The differences between the three collections are all such as may be regarded as within the limits of variation to be expected in a single species of this genus.

***Sebacina obscura* sp. nov.**

Fig. 5

Effusa, indeterminata, tenuissima, arachnoidea, subinvisibilis; basidiis primum globosis, dein truncatis, sessilibus, 8μ diam., demum cruciato-septatis; epibasidiis nullis; basidiosporis elliptico-fusoideis, $9-10 \times 4 \mu$.

Broadly effused, indeterminate, very thin, appearing as a faint, whitish arachnoid growth on substratum, beneath which a grayish gelatinous film appears when soaked; basidia globose, sessile on repent hyphae, becoming cruciate-septate and then appearing truncate at apex; epibasidia lacking, each basidial segment producing a short, slender sterigma directly, upon which a basidiospore is produced; basidiospores elliptical-fusoid, somewhat curved, $9-10 \times 4 \mu$; germination not seen.

PANAMÁ: Canal Zone. Summit, July 19, 1935. G. W. M. 2873, Type. On dead leaf-stalk of date palm still attached to living plant. In herb. Univ. Iowa; portion in herb. Missouri Bot. Gard.

Although this species is inconspicuous, it was readily seen with the naked eye and tentatively assigned to *Sebacina* after examination with a hand lens. It lacks cystidia, hence belongs in the section *Eusebacina* as defined by McGuire (Lloydia 4: 11. 1941) although the basidia suggest those of certain species of the section *Bourdotia*, especially *S. Grandinioides* and *S. Eyrei*, but there is no evidence of the erect hyphae bearing clusters of basidia at the tip subtended by the bract-like remnants of discharged basidia so typical of those species. On the contrary, the basidia are broadly sessile on repent hyphae. The curious truncate aspect of the developing probasidia in lateral view and the subfusiform spores are characteristic. It is quite probable that the lack of an epibasidium in this species, as in the arid Bourdotias, is a reflection of the lack of a gelatinous layer interposed between the body of the basidium and the air in which the basidiospore must be formed.

TJIBODASIA BRUNNEA Martin

This species was based on a Brazilian collection sent to me by the Rev. J. Rick. In the description (Lloydia 4: 262. 1941) the color, based upon the soaked specimen, was given as brown and this suggested the specific name assigned. In a letter written since its publication, Father Rick informs me that when fresh the hymenium is white. Holtermann (Mykol. Unters. aus den Tropen 44. 1898) describes *T. Pezizoides*, the type and only other species of the genus, as yellowish red when fresh. The difference in color furnishes an additional reason for regarding the species from Brazil as distinct from the Javanese species. It is unfortunate, however, that the specific name assigned should be misleading so far as the appearance of the living fungus is concerned.

Pellicularia biapiculata Rogers, sp. nov.

Fig. 6

Fructificatio hypochnoidea, alutacea, sub lente minute manipularis; hyphae plerumque breviter articulatae, rectangule vel pseudodichotome ramosae, enodulosae, (4.5-) 7-10 (-12.5) μ diam.; basidia obovato-clavata, 14-17 \times 10-10.5 μ , sterigmata 4 subuliformia, 5.5-7 μ longa, gerentia; sporae biapiculatae, corpore centrali ellipsoideo, 10-11.5 \times 6.5-7 μ , tunica incrassata, verruculis minutis ornata, haud per repetitionem germinantes.

Fructification hypochnoid, between Pinkish Buff and Cream Buff (R), under the binocular coarsely tufted; hyphae mostly short-celled, branching at right angles, or pseudodichotomous, without clamps (4.5-) 7-10 (-12.5) μ in diameter, with a hyaline plug in the septal pore, the basal sometimes long-celled, slightly thick-walled, yellowish; basidia obovate-clavate, 14-17 \times 10-10.5 μ , bearing 4 subulate sterigmata 5.5-7 μ long; spores biapiculate, with a short-ellipsoid central body, tapering abruptly to the laterally borne truncate true apiculus and more gradually to the obtuse false apiculus, 10-11.5 \times 6.5-7 μ , the wall minutely tuberculate, strongly refractive, moderately or greatly thickened (-1.5 or even 2 μ), not germinating by repetition.

BRAZIL: Estado do São Paulo. São Leopoldo, December, 1939. Rev. J. Rick, Type. In herb. Univ. Iowa 1555.

In appearance of the fructification to the naked eye and under the binocular, and in all microscopic characters but the spore-wall, *P. biapiculata* closely resembles certain forms of *P. flavescens* (Bon.) Rogers. The sterigmata are somewhat smaller than those usually shown by *P. flavescens* but not smaller than those of some specimens of the latter fungus (compare the figures here given with those in Univ. Iowa Stud. Nat. Hist. 17, pl. II, fig. 8). The spores of *P. biapiculata* do not germinate by repetition, while those of *P. flavescens* commonly do. The chief differences, however, which seem sufficient to make necessary the separation, are the great

thickening of the spore-wall in *P. biapiculata* and its minutely warted surface.

In the key to the genus *Pellicularia* published in Farlowia 1: 97, 98, the present species would be sought under dichotomy no. 3, where it may be inserted as a third choice:

"3. Spores biapiculate *biapiculata*."

Pellicularia digitata Rogers, sp. nov.

Fig. 10

Fructificatio tenuis, pruinosa, pallide cremea, sub lente farinoso-arachnoidea, setulis minutis ornata; hyphae breviter articulatae, rectangule ramosae, enodosae, 6-11 μ diam.; cystidia tenuiter tunicata, laevia, hyalina, plerumque aseptata, subcylindracea vel digitiformia (spathulata), obtusa, 60-105 \times 10-12 μ ; basidia ad basim ventricosa, parte superiore subcylindracea, 17-22 \times 9-10.5 μ , sterigmata 4 parva, 2.5 μ longa, gerentia; sporae ellipsoideo-fusiformes vel naviculiformes, 10.5-11.5 \times 4-5.5 μ , laeves, hyalinae.

Fructification pruinose, lighter than Ivory Yellow (R), under the binocular delicately farinose-arachnoid, set with minute hyaline setulae; hyphae short-celled, branching at right angles and with abundant cruciform cells, without clamps, 6-11 μ in diameter, the basal strands longer-celled and with walls somewhat thickened; cystidia thin-walled, even, subcylindric, digitiform, or spathulate, rarely once-septate, 60-105 \times 10-12 μ ; basidia borne in fairly regular cymes, at first stout-obovate, at maturity with ventricose base and narrowed subcylindric apical portion, 17-22 \times 9-10.5 μ , bearing 4 small curved sterigmata (2.5 μ in length); spores long-ellipsoid-subfusoid to navicular, obtuse at the apex, with a thick truncate apiculus at the base, colorless and even-walled, 10.5-11.5 \times 4-5.5 μ .

PANAMÁ: Prov. Chiriquí. Valley of upper Rio Chiriquí Viejo, 1600-1800 m., Aug. 3, 1935. G. W. M. 2387, Type. On completely charred wood. In herb. Univ. Iowa.

Pellicularia digitata resembles *P. ansosa* Jackson & Rogers, from which it differs most obviously in complete lack of clamps, and also in the often spathulate cystidia, the larger spores, the basidia invariably strongly ventricose, and the possession of four rather than six sterigmata. In the key to *Pellicularia* published in Farlowia the present species may be distinguished by an alteration in the choices provided under no. 7:

"7. Cystidia thick-walled, etc. 6. *ochroleuca*
 7. Cystidia thin-walled, etc. 7. *bis*
 7 bis. Hyphae with clamps 7. *ansosa*
 7 bis. Hyphae without clamps. *digitata*"

Peniophora gemmea Rogers, sp. nov.

Fig. 9

Fructificatio tenuis, pallide lilaceo- vel ochraceo-grisea, sub lente subtiliter medullosa, minutissime guttifera; hyphae zygodesmatibus praeditae, $2.5\text{--}5\mu$ diam.; cystidia tenuiter tunicata, longe emergentia, obtusa, subulata, $70\text{--}90 \times 2\mu$, ad basim ventricosa, ad 4μ diam.; basidia ventricosa, $15\text{--}20 \times 5.5\text{--}6\mu$, sterigmata 4 recta gerentia; sporae oblongae, lateraliter apiculatae, $6\text{--}8.5 \times 4.5\mu$.

Fructification thin, separable in small bits, when dry pruinose-crustose, under the binocular minutely reticulate-poroid (with the appearance of fine-grained bread), dotted with very small droplets of amber-colored resin, in color between Pale Vinaceous Fawn and Tilleul Buff (R); hyphae loose, distinct, $2.5\text{--}5\mu$ in diameter, with clamps throughout; cystidia very slender, obtuse-subulate, thin-walled, long-emergent, $70\text{--}90\mu$ long, about 2μ in diameter, somewhat ventricose at the base and there up to 4μ in diameter, borne among the basidia; basidia at first obovate, then short-clavate, at maturity with a ventricose base $5.5\text{--}6\mu$ in diameter abruptly narrowed to a subcylindric or narrowly clavate apical portion 4μ in diameter, the whole $15\text{--}20\mu$ long, bearing 4 slender straight sterigmata $4\text{--}4.5\mu$ long; spores oblong, obtuse at both ends, somewhat drawn out to the truncate, distinctly lateral apiculus, $6\text{--}8.5 \times 4.5\mu$.

COLOMBIA: Dept. Magdalena. Cerro Quemado trail above Hacienda Cincinnati, 1500–2300 m., Sierra Nevada de Santa Marta, Aug. 24, 1935. G. W. M. 3698, Type. In herb. Univ. Iowa.

The present species is a member of *Peniophora* sect. *Gloeocystidiales* Bourd. & Galz., and of a group of species, characterized not only by thin-walled, gloeocystidioid cystidia but also by the presence of resin-dots in the hymenium, which may for the present be considered a subsection of that section. This group includes *Peniophora argillacea* (Bres.) Sacc. & Syd., *P. fusca* Burt, *P. medioburiensis* Burt, *P. montana* Burt, *Corticium pallidum* Bres., and *Gloeocystidium macedonicum* Litsch. From all of these species *P. gemmea* differs in the extremely slender cystidia and the relatively minute oblong spores. In the key to *Peniophora* in the Hyménomycètes de France the present species would fall in dichotomy no. 74 (p. 277), where it would be distinguished by "Spores oblong; hyphae $2.5\text{--}5\mu$."

TROPICAL STIPITATE STEREUMS

The stipitate Stereums are predominantly tropical and warm temperate fungi. The numerous species established by earlier mycologists, such as Fries, Montagne, Léveillé, Berkeley and Cooke, were based almost entirely upon external characters. These were compiled by Massee (Jour. Linn.

Soc. Bot. 27: 158-177. 1890) but little was added to the original descriptions. Lloyd (Myc. Writ. 4. Stipitate Stereums 15-44. 1913) also stresses external characters, but gives excellent photographic illustrations of numerous species and suggestive comments on synonymy; Burt (Ann. Missouri Bot. Gard. 7: 81-116. 1920: 13: 325-326. 1926) brought a high degree of order into the group by paying careful attention to hymenial structures and spore size, and while his main divisions continue to be based on habit, the impression given by his work is that related species have, for the most part, been grouped together. The separation between central-stemmed and lateral-stemmed species appears to be unduly stressed and the size and shape of gloecystidia are less reliable than would seem to be suggested, although the presence or absence of these structures appears to be significant.

Burt lists seven species of stipitate Stereums with gloecystidia: *Ravenelii*, *surinamense*, *pergamenum*, *elegans*, *cristatum*, *decolorans* and *aculeatum*. To these should be added *S. tomentipes* Overholts (Myc. Expl. Venezuela 308. 1934). I have collections which I refer to the first four species and submit the following comments on them and on certain of the non-cystidiate species in the hope that they may serve to clarify our knowledge of the group.

STEREUM RAVENELII Berk. & Curt.

Originally described from South Carolina, Burt (l.c. 7: 90) lists additional collections from Alabama, Louisiana, Mexico, the West Indies and Brazil. As Burt notes, the species is close to *S. pergamenum*. He states that it is constantly infundibuliform, with a slender and more conspicuous stem than that species and that it grows from the soil rather than on dead wood. The microscopic characters are not significantly different. The differences do not seem very convincing. I have, however, a single, fairly ample collection (G. W. M. 2056) growing in peaty soil on the Llanos del Volcán, Chiriquí, which seems clearly distinct from the specimens referred to *pergamenum* not only in its habitat and slender stem, but in its brighter and thinner pileus. Most of the fructifications are infundibuliform, but a few are flabellate. Burt gives the size of the spores as $3-4 \times 2.5-3\mu$. I find them distinctly larger, $5-6 \times 3.5-4\mu$, in this respect very close to *pergamenum*.

STEREUM SURINAMENSE Lév.

Burt (l.c. 7: 91), upon whose excellent description I base the reference of my specimens to this species, gives the range as the West Indies, Honduras and Dutch Guiana. Lloyd (l.c. 26) says it is common in the tropics and illustrates a very large specimen from Samoa. It may be recognized by its thin, usually infundibuliform pileus, abundant gloecystidia and small, broadly oval spores, $3-4 \times 2-3\mu$. It appears to be one of the common-

est species on Barro Colorado Island, represented by eight collections. I also have a collection from the Canal Zone, east of Arraiján, and refer here a collection from Nicaragua by C. L. Smith. Burt keys it out as a species which is always infundibuliform as contrasted with those that may sometimes be lateral-stemmed. As in the case of *S. Ravenelii*, this is not quite accurate, as occasional pilei may be nearly or quite flabellate and in one small collection, consisting of two pilei, both are bilabiate, the two lips extended horizontally as in a scrophulariaceous blossom, the hymenium being on the lower side of each lip, hence the hymenium of the upper lip is borne on the morphological surface which is customarily sterile.

STEREUM PERGAMENUM Berk. & Curt.

The distribution of this species is, according to Burt (l.c. 7: 101), "Ohio and North Carolina to Mexico and in the West Indies." Burt suggests that the name may be a synonym of the previously published *S. nitidulum* Berk., and Overholts (Sci. Surv. P. R. 8(1): 154. 1926), in reporting it from Puerto Rico, uses the latter name, noting that the species occurs in Brazil, Ceylon and Australia. Lloyd (l.c. 25, 27) illustrates both species, which he treats as distinct, although with no reference to microscopic characters. Burt keys it among those forms which may be either infundibuliform or lateral-stemmed. I have nine collections from the Sierra Nevada de Santa Marta of Colombia which I refer to this species. There is rather a wide range of variation, not only between different collections but between pilei from the same collection, but the differences are in such characters as size, central or lateral attachment of stipe, color and length and hairiness of stem, with practically complete gradation throughout. Some collections were growing directly on wood, others on soil, presumably from buried wood. All have smooth, oval, conspicuously guttulate spores, $4.5-5.5 \times 3-4\mu$ and all have gloeocystidia. There is a gradation in length and staining capacity of the gloeocystidia from younger to older parts of the hymenium, but this is true of all gloeocystidiolate species I have studied. The hymenium of the older fructifications is denser and more strongly agglutinated than that of the younger. Some of the specimens would fit the description of *S. tomentipes* Overholts (Myc. Expl. Venezuela 308. 1934), but the characters which Overholts stresses are precisely those which appear to vary within wide extremes in this species, as in *P. surinamense*. In view of the gradation noted and the general satisfactory agreement with Burt's description of *S. pergamenum*, it seems wise to assign them, with the others, to the older species. Two specimens collected by C. L. Smith in Nicaragua appear to belong here.

STEREUM ELEGANS (Meyer ex Fries) Lloyd

Originally described from what is now British Guiana, Lloyd (l.c. 24) speaks of *S. elegans* as "widespread in the tropics of both hemispheres."

Burt (l.c. 7: 105) gives the range as Puerto Rico to British Guiana, although he refers to the type, incorrectly, as from Dutch Guiana. Cleland (Fung. S. Austr. 251. 1935) notes its occurrence in South Australia, Victoria, New South Wales and Queensland. Both Lloyd and Burt note the fact that various other *Stereums* have from time to time been referred incorrectly to *S. elegans*. Burt's concept of the species, fortified by the original description, which he quotes, calls for densely caespitose, brown, azonate, more or less petaloid pilei conrescent above, with an ashy, plicate hymenium containing gloeocystidia. The spores he describes as hyaline, even, subglobose, $3.5-4.5\mu$ in diameter. I have a single, but very abundant collection from the Sierra Nevada de Santa Marta (G. W. M. 3574) which is clearly referable to this species. Two or three hundred of the bright tan pilei with pale hymenial surfaces were growing from buried wood in a dense cluster, the stems distinct, but the upper portions grown together in tufts of varying size and degrees of complexity. Very few could be described as infundibuliform. Burt says the gloeocystidia are barely distinguishable. They are perhaps somewhat less conspicuous than in the other species, nevertheless they are clearly apparent in thin sections stained in Phloxine and even more so when such sections are slightly crushed. The hyphae bear rather conspicuous clamp-connections, which I have failed to observe in the other species studied. Copious spore prints were secured; spores from these were broadly oval, $5-5.5 \times 3-3.5\mu$. A collection from Hainan, China (S. Q. Deng 4442), distributed by S. C. Teng as this species, has broadly oval or nearly subglobose spores, those which appear to be mature being about $5 \times 4\mu$. I believe it is correctly determined. Cleland (l.c.) describes the spores as "subspherical, smooth, hyaline, $5-6 \times 3.5-4\mu$."

STEREUM CYPHELLOIDES Berk. & Curt.

Fig. 7

Originally described from Cuba (Jour. Linn. Soc. Bot. 10: 331. 1868), Burt (Ann. Missouri Bot. Gard. 7: 112. 1920) lists an additional collection from Puerto Rico. In his key to species, Burt distinguishes *S. Cyphelloides* from *S. pusiolum*, in part, by saying that the former grows on wood, the latter on the ground. The original description says: "on the ground amongst moss." Masee (Jour. Linn. Soc. Bot. 27: 172. 1890) adds little to the original description, but describes the spores as globose, 4μ in diameter. Burt describes them as hyaline, even and $4-5 \times 3-3.5\mu$. He emphasizes the soft, bibulous texture of the pileus and the absence of cystidia or gloeocystidia, and gives the thickness of the pileus as up to 600μ .

What I am convinced is this species was extremely common in 1935 in the Sierra Nevada de Santa Marta of Colombia. It is represented by four collections (G. W. M. 3203, 3229, 3402, 3526) but many more could have

been made. All were growing directly from the soil of steeply inclined, sandy banks, some almost bare, others more or less covered with mosses, liverworts and lichens. The tiny spatulate pilei, up to 12 mm. long and 10 mm. wide, but mostly smaller, were pure white when collected but are now pinkish buff (R) on both surfaces. The larger pilei are up to 1000μ thick just above the base, gradually thinning to 150μ at the margin. The hyphae are slender, gelatinized and without clamp-connections and the basidia are long-clavate and 4-sterigmate, $26-28 \times 4-5\mu$ excluding sterigmata. The spores are very curious. They are colorless, at first oval or pip-shaped, $5-6 \times 3-3.5\mu$, essentially as Burt describes them, but by far the larger number seen are curiously angled and distorted and their dimensions are then altered so that many are 7μ long and proportionately thinner, while others are angularly globose.

Because of their pure white color and despite their small size, the pilei are strikingly conspicuous against the background of dark earth in which they grow. While travelling by truck from El Volcán to Concepcion in Chiriquí, Panamá, in July, 1935, I saw a steep earth bank bearing hundreds of pilei of what must have been this species. As the road was well-nigh impassable and an imminent tropical deluge threatened to make it completely so, it was not possible to stop for a collection, but the observation suggests that the species may be common in the tropics.

STEREUM HYDROPHORUM Berk.

This is a rather large species characterized by a deep funnel-shaped, velvety pileus and usually a relatively long stem. Burt (l.c. 7: 89) gives its range as Venezuela, British Guiana and Brazil and adds "it may possibly occur also in the West Indies or Central America." A single collection from Barro Colorado Island (G. W. M. 3089) seems to belong here. The stem is very short, being almost entirely replaced by a conical tomentose pad, and the colors are somewhat paler and brighter than those given by Burt, but the large, leathery pileus, the hymenium lacking noteworthy structures other than basidia, and the small globose or subglobose spores $3-3.5\mu$ in diameter seem to be ample warrant for the reference.

STEREUM RADICANS (Berk.) Burt

Fig. 8

The original description, as quoted by Burt (l.c. 7: 108), gives little that is distinctive other than the statement that the stem gives off strongly branched roots at the base. Burt did not see the type but based his concept of the species upon a collection from Cuba by Wright which had been determined by Berkeley, and included with it five other specimens from the West Indies and British Honduras. From Burt's discussion, as from his illustrations, it may be inferred that the radicating base is not a constant

character, stress being placed upon the raised lines upon the upper side of the thick pileus, the variable color, the lack of cystidia and gloecystidia and the spores, at first globose, then angular. I have three collections which I refer to this species, one from Barro Colorado Island, one from the Province of Panamá and one from the Sierra Nevada de Santa Marta. All were growing on wood and none shows a radicating base, but in other respects they fit Burt's description very satisfactorily. The two collections from Panamá show only the roughened or angular spores, but a good spore print was secured from the Colombian collection, the spores from the print being smooth, nearly globose and about $6-7\mu$ in diameter, somewhat larger than the dimensions $6 \times 5\mu$ given by Burt. Angular spores were present to a slight extent in the spore print and abundant on the hymenium of this specimen. All three collections approach *Cladoderris*.

STEREUM HARTMANNI (Mont.) Lloyd

The distinctive characters of this species are the greatly incised tips and margins with hymenium-bearing teeth on the edges and often on the lower surface. Originally reported from "Carolina" it has, according to Lloyd, never again been collected in the southern United States. Lloyd (l.c. 34) gives its range as the West Indies; Burt (l.c. 7: 112) adds Bolivia. What is either this species or a closely related and apparently undescribed species is represented by a collection made by Dr. R. E. Woodson, Jr., south of Las Cruces, Canal Zone, August 5, 1937. The pilei are now tan with pallid hymenium and white stipes and may well have been white or whitish when collected. The spores are subglobose, $4.5 \times 3.5\mu$, which accords perfectly with the dimensions given by Burt, and the hymenium contains neither cystidia nor gloecystidia. This is scarcely a *Stereum* in the usual sense, since the "teeth" stressed by Burt occur not only on the margin but abundantly rather than rarely on the hymenial surface. In places they are elongate and radial, suggesting portions of gills; elsewhere they anastomose, forming incomplete pores. There is no suitable genus to receive such a fungus, but *Stereum* may be stretched to accommodate it for the present.

CLAVARIA MUCIDA Pers. ex Fries

In commenting on collections of this species from Panamá and Colombia (Lilloa 5: 191. 1940) I stated that the basidiocarps were pendent. This was based on misinterpretation of a note on the packet of one of the collections, aided by a faulty memory. In my field notes, made at the time of collection, both collections are recorded as growing erect exactly as does *Calocera*.

CLAVARIA AURANTIO-CINNABARINA Schw.

Through the kindness of Professor H. H. Whetzel I have been permitted

to examine the portion of the collection from Venezuela reported by Overholts (in Chardon and Toro, Mycol. Expl. Venez. 306. 1934) and entered in the Cornell collection as Fungi of Venezuela 824. This specimen shows the same curious geniculate basidia which I described and illustrated in reporting the species from Barro Colorado Island (Lilloa 5: 195. 1940, fig. 5).

✓ ***Cymatella longipes* sp. nov.**

Fig. 11

Fructificatio marasmioides; pileo subinfundibuliformi, subgelatinoso, albo, 1-2 mm. lato; stipite filiformi, glabro, 16 mm. longo, superne albo, inde abrupte flavo-brunneo et paulatim ad basim nigro; hymenio inferiore, glabro; basidiis clavatis, $30-35 \times 7\mu$; basidiosporis sublacrimaeformibus apiculatis, $9-11 \times 4\mu$.

Fructifications marasmiod, solitary or in small clusters of two or three, pileate and stipitate, arising from a small basal pad; total height 14-18 mm.; pileus cupulate to broadly funnel-shaped, subgelatinous, 1-2 mm. broad and slightly less in depth, pure white when fresh, drying translucent yellow-brown and horny; upper surface sterile; hymenium on lower surface, smooth, without cystidia; stipe slender, hairlike, up to 16 mm. long and $150-185\mu$ in diameter, pure white just below pileus then abruptly yellow-brown, shading to nearly black at glabrous, pulvinate base; basidia simple, slender, clavate, 4-spored, $30-35 \times 7\mu$; basidiospores sublacrimate, apiculate, $9-11 \times 4\mu$.

COLOMBIA: Sierra Nevada de Santa Marta, 1250-1500 m. Aug. 17, 1935. G. W. M. 3469, Type. On bark of fallen branch.

The genus *Cymatella* was established by Patouillard (Bull. Soc. Myc. Fr. 15: 193. 1899). It was based on a collection from Guadeloupe, *C. minima* Pat., to which were added by transfer *Craterellus Marasmioides* B. & C. and *C. pulverulentus* B. & C., both from Cuba. Patouillard describes the cap as without a pellicle, contrasting it in this respect with *Skepperia*, in which the upper surface is pelliculose, composed of swollen, cystidium-like cells which may also occur as a delicate pubescence on the stipe. He emphasizes the resemblance of *Cymatella* to *Marasmius* and suggests that its species are essentially species of *Marasmius* without gills. He states emphatically that they have nothing in common with *Cantharellus* nor should they be regarded as teratological forms of *Marasmius*.

In the species under discussion, there are vesicular cells on the upper surface of the pileus, particularly at the center. In no other respect, however, does it suggest *Skepperia*. The stipe is slender, very long in proportion to the pileus, and, both when wet and dry, the resemblance to *Marasmius* is striking.

Höhnelt (Sitzungsb. K. Akad. Wiss. Wien, Math.-Nat. Kl. Abt. I., 119: 887. 1910) points out that *Cymatella* and *Discocyphella* P. Henn. (Monsunia

1: 43. 1899)* are synonyms, published practically simultaneously. He selects *Cymatella* as preferable, since it is more clearly described and is based on a better understanding of the relationships of the fungus, and transfers Hennings' two species to *Cymatella*. He suggests that both *Gloiocephala* Masee (*Grevillea* 21: 33. 1892) and *Hymenogloea* Pat. (Tax. Hymén. 147. 1900) may also belong to the same genus. If this is true, Masee's generic name would, of course, be valid, but Höhnel does not actually propose combining these genera and reference to Masee's original description and illustration is far from convincing.

Burt (Ann. Missouri Bot. Gard. 11: 6. 1924) lists Patouillard's three species and reports an additional collection of *C. pulverulenta* from Puerto Rico. Referring to this collection, he states: "the specimens are not notably marasmiod in the recent specimens I have seen and the genus seems unnecessary."

The Colombian collection here reported seems quite distinct from any of the five previously recognized species, but is perhaps closest to *Cymatella ciliata* (P. Henn.) Höhn. described from Chile. From this species it differs in its pure white pileus and stem apex, the lack of coarse hairs at the base of the stem and the much longer spores. It is definitely marasmiod, far removed from *Craterellus*, in which genus Burt implies *Cymatella* should be included, and has little but superficial characters to justify reference to the stipitate Stereums. Except for the vesiculose cells in the upper surface, *Cymatella*, as defined, fits it exactly and seems to be needed for this and for its presumed relatives.

Killermann (in Engler & Prantl, ed. 2. 6: 259. 1926) includes *Cymatella* in the tribe Marasmieae of the Agaricaceae, which is in accord with Patouillard's view of its relationships. He publishes an illustration of *C. minima* (Fig. 149 C) said to be "nach Patouillard." Reference to Patouillard's original figure (l.c. Pl. 9, Fig. 6), reproduced in part as Fig. 73 of the Essai Taxonomique and copied by Burt, shows that Killermann's figure is highly formalized and imaginative, particularly in the unwarranted emphasis of the very faint radiating folds, which are made to appear as blunt gills.

I wish to express my indebtedness to Dr. L. E. Wehmeyer of the University of Michigan for the description and illustrations of *Pseudovalsa tropicalis*, to Dr. D. P. Rogers of the American International College for the descriptions of *Pellicularia biapiculata*, *P. digitata* and *Peniophora gemmea* and to Mrs. D. P. Rogers for the drawings illustrating these species.

* In Engler & Prantl, ed. 2. 6: 151 the page reference to Hennings' name is given as 141. I have not seen the original.

Studies in the Simaroubaceae. III. The Genus *Simaba*

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The genus *Simaba* was proposed in 1775 by Aublet, in his *Histoire des Plantes de la Guiane Francoise*, the single species being named *S. guianensis*. In the same work Aublet proposed the genus *Aruba*, with *Aruba guianensis* as the type. It is apparent from the figures and descriptions that the two genera were founded on different collections of the same species. Although *Aruba* has page priority, *Simaba* was until 1891 unanimously adopted by other authors, who reduced *Aruba* to synonymy.

In 1891 Otto Kuntze transferred all the names in *Simaba* to *Aruba*, presumably because of page priority. According to the present International Rules, these transfers were not validly published, since he gave neither descriptions nor references to previously published descriptions. The names are accordingly omitted from the synonymy of the species. Three other names, *Phyllostema*, *Zwingeria*, and *Homalolepis*, have been given to this genus, but are universally and correctly reduced to synonymy.

Simaba is related on the one hand to *Quassia*, and on the other to *Simarouba*. From *Simarouba* it is well separated by its perfect flowers and capitate or slightly lobed stigmas, *Simarouba* having unisexual flowers and long divergent stigmas. A helpful vegetative character is that the leaflets of *Simaba* are usually opposite, while those of *Simarouba* are almost always offset.

Quassia, as represented by *Quassia amara* L., differs from *Simaba* in its broadly winged leaf rachis, ordinarily racemose inflorescence, erect petals which are glabrous except for a few hairs near the base within, and conspicuously jointed pedicels. *Simaba* has a wingless leaf rachis, paniculate inflorescence, pubescent petals which are more or less spreading at anthesis, and pedicels which are jointless or sometimes jointed at the base. The African species which has been referred to *Quassia*, *Q. africana*, resembles *Simaba* in its wingless leaf rachis, jointless pedicels, and spreading petals. Although it was described as having a raceme, specimens at hand are clearly paniculate. It resembles *Quassia* in having the petals hairy only at the base, and in the short broad appendages of the filaments. Mere distribution of hair on the petals scarcely seems of great importance, and the size and shape of the appendage is highly variable in *Simaba*. I believe it is better to refer *Q. africana* to *Simaba*, as Baillon at first did, leaving *Quassia* as a monotype.

Another African genus, *Odyndea*, is probably not to be separated from *Simaba*, the only distinctions ever having been brought out residing in the aestivation of the corolla, being apparently fictitious.

Engler has proposed three sections in the genus, which are here maintained. The small-flowered species, with the petals merely puberulent, form the section *Tenuiflorae*; the species with flowers of moderate size and the petals villous-tomentose make up the *Floribundae*, and the very large-flowered species with the petals villous-tomentose form the *Grandiflorae*. *S. africana*, and probably at least some of the species now referred to *Odyndea*, should be segregated into a fourth section, but we are here concerned only with the American species.

The section *Tenuiflorae* is confined to the moist regions of the Amazon basin and northward; the sections *Floribundae* and *Grandiflorae*, with the exceptions of *S. paraensis* and *S. cedron*, are limited to the drier and more open regions of southern and eastern Brazil, and Paraguay. There is a cleaner break between the *Tenuiflorae* and *Floribundae* than between the *Floribundae* and *Grandiflorae*. It is interesting to note that on the basis of anatomy Boas has proposed two sections; *Aruba*, for the species without secretory passages, coinciding with Engler's *Tenuiflorae*; and *Homalolepis*, for the species with secretory passages, including Engler's *Floribundae* and *Grandiflorae*.

The main evolutionary trend in the genus has been toward the development of larger flowers, with long, narrow, firm petals, and long slender appendages of the filaments. Beyond that, and the statements of affinity given with the notes on the species, I do not feel able to elucidate the phylogeny of the group.

The genus includes species of very diverse habit, from good-sized trees to small shrubs or subshrubs, and suffruticose plants with the leaves all basal. Where information is available, I have included habit notes in the key, but these must be used with caution, since data is scanty, and several of the species may be either arborescent shrubs or trees. Precise limits of measurements of flower parts are likewise subject to change as more material is accumulated.

It seems noteworthy that of the 24 species recognized in this paper, 19 were described by 1874, when Engler's excellent treatment appeared in the *Flora Brasiliensis*, and only 5 others, all valid, have been proposed since. Probably two more undescribed species are represented among the sheets assembled for this study, but the specimens are either sterile or only in bud, so they must remain undescribed for the present.

I wish to thank Dr. R. T. Major, Director of the Research Laboratory of Merck & Co., Inc., who made this study possible, Dr. H. A. Gleason, Dr. Bassett Maguire, Mr. B. A. Krukoff, of the New York Botanical Garden, who have given helpful advice and criticism, and aided in obtaining necessary material, and the curators of the following herbaria (designated hereinafter by the letters at the left), who have loaned specimens for study:

A—Arnold Arboretum, Harvard University,

F—Field Museum, Chicago, Ill.

G—Gray Herbarium, Harvard University,

MO—Missouri Botanical Garden, St. Louis,

Mich—University of Michigan, Ann Arbor,

NY—New York Botanical Garden,

US—United States National Herbarium, Washington, D. C.,

Y—Yale University School of Forestry, New Haven, Conn.

Specimens cited as Kr. Herb. are mostly vouchers received by Mr. Krukoff in connection with samples for chemical analysis. In cases of some contemporary South American collectors, herbarium distribution numbers have been cited as if they were collector's numbers, both to identify the collection and because it is sometimes difficult to tell whether the number accompanying the specimen is that of the collector or that of the herbarium.

All measurements of flower parts are taken from flowers restored to normal size by boiling.

SIMABA Aubl.

Trees, shrubs, or suffrutescent plants with the leaves all basal; leaves pinnately compound, with usually opposite leaflets, only the terminal one present in two species; inflorescence a simple or mixed panicle; pedicels not jointed, or sometimes jointed at the base; flowers perfect; sepals 4-5, united at the base or to above the middle; petals 4-5, distinct, pubescent, more or less spreading at anthesis; stamens twice as many as the petals, each bearing a more or less hairy appendage which may be attached throughout or merely joined at the base; gynoecium borne on an evident disk or gynophore; carpels 4-5, weakly united, each bearing one ovule; style 1, but the part from each carpel discernible; stigma capitate or slightly lobed; fruit of several distinct drupes, sometimes only one maturing.

KEY TO THE AMERICAN SPECIES

1. Petals 4-7 mm. long, merely puberulent on both sides. (*Tenuiflorae*)
2. Leaflet 1; appendage with only the two points of the tip free.
 3. Leaves borne on well developed petioles about 4-15 mm. long; petals evidently puberulent on the outside; appendage long-hairy within, the hairs conspicuously spreading beyond the margins; small tree. 6. *S. obovata*
 3. Leaves subsessile, the petioles only 1-3 mm. long; petals very nearly glabrous on the outside; appendage short-hairy within, the margins nearly smooth; shrub 1 m. high or less. 7. *S. monophylla*
2. Leaflets several; flowers various.
 3. Fruit short-pilose with brownish hairs, about 3 cm. long; arborescent shrub 2-4 meters tall. 4. *S. crustacea*
 3. Fruit glabrous or finely puberulent, 1-3 cm. long.
 4. Free portion of the appendage very short, much shorter than the attached portion; appendages about 1.8 mm. long or less, equalling or shorter than the ovary; inflorescence, at least in *S. multiflora*, ample, many-flowered; fruit mostly 1.5-3 cm. long; leaflets from obovate and rounded at the tip to lanceolate and acute, sometimes abruptly short-cuspidate.

5. Appendages less than half as long as the gynophore; fruit slender, asymmetrical, 2.5-3 cm. long; tree..... 5. *S. orinocensis*
5. Appendages equalling or surpassing the gynophore; fruit stout, symmetrical, 1.5-2.5 cm. long; aborescent shrub, or sometimes a tree as much as 15 meters high. 3! *S. multiflora*
4. Free portion of the appendage longer than the attached portion; appendages equalling or surpassing the ovary, usually 1.8 mm. long or more, sometimes a little less; inflorescence small, relatively few-flowered; fruit about 1-1.5 cm. long; leaflets narrowly diamond-shaped to broadly elliptical or ovate, obtuse and emarginate at the apex to abruptly cuspidate or frequently abruptly long-acuminate.
 5. Petals about 6-7 mm. long; filaments about 4.7-6.0 mm. long; arborescent shrub or small tree..... 2. *S. guianensis*
 6. Leaflets with a long acuminate tip..... 2a. *S. guianensis* var. *typica*
 6. Leaflets obtuse or short-pointed..... 2b. *S. guianensis* var. *ecaudata*
 5. Petals about 4-6 mm. long; filaments about 3.0-4.7 mm. long; arborescent shrub 2-4 meters tall, or sometimes a small tree..... 1. *S. cuspidata*
 6. Leaflets with a long acuminate tip..... 1a. *S. cuspidata* var. *typica*
 6. Leaflets obtuse or short-pointed..... 1b. *S. cuspidata* var. *nigrescens*
1. Petals 7.5-30 mm. long, the surfaces closely villous-tomentose and often ferrugineous.
 2. Petals 7.5-16 mm. long; filaments 5-10 mm. long; appendages 3-7 mm. long. (*Floribundae*)
 3. Suffruticose; leaves all basal.
 4. Inflorescence precocious; petals 10-12 mm. long; filaments 8 mm. long; appendage free for about the upper $\frac{2}{3}$ 16. *S. praecox*
 4. Inflorescence appearing with the leaves; petals about 8-9 mm. long; filaments about 5-5.5 mm. long; appendage free for less than half its length..... 17. *S. suffruticosa*
 3. Trees, shrubs, or subshrubs; cauline leaves present.
 4. Leaflets 15-20 pairs; tree 4-5 meters tall..... 18. *S. insignis*
 4. Leaflets 2-6 pairs.
 5. Appendages with only the two points of the tip free, the rest joined to the filament.
 6. Leaves velvety-pubescent beneath; small shrub or subshrub about 1 meter high. 11. *S. warmingiana*
 6. Leaves essentially glabrous beneath, except sometimes on the midrib.
 7. Calyx parted to about the middle; gynophore apparently about 4 mm. long; shrub..... 9. *S. floribunda*
 7. Calyx parted to near the base; gynophore 1-2 mm. long.
 8. Small shrub or subshrub of Sao Paulo, Brazil, to Paraguay, not over 1 meter tall; petals 2 mm. wide or less; midrib of the leaflets light-colored; main veins visible beneath as evident furrows or light-colored ridges; leaves glabrous..... 10. *S. glabra*
 8. Medium-sized or large tree of Para and Amazonas, Brazil; petals 2.3-3.7 mm. wide; midrib and main veins of the leaflets usually dark beneath; leaflets often with a few hairs beneath, especially along the midrib..... 8. *S. paraensis*
 5. Appendage with the upper part free from the filament.
 6. Leaves velvety-pubescent beneath; subshrub less than 1 meter high..... 12. *S. ferruginea*
 6. Leaves essentially glabrous beneath, except sometimes on the midrib.
 7. Filaments 9-10 mm. long; appendage 7 mm. long; petals 12-16 mm. long. 19. *S. intermedia*
 7. Filaments 5.0-7.5 mm. long; appendages 3.2-3.8 mm. long; petals 7.5-10.5 mm. long.
 8. Appendage free almost to the base; inflorescence narrow; presumably a small shrub..... 15. *S. suaveolens*
 8. Appendage with only about the upper half free from the filament; inflorescence ample, the branches divaricate.
 9. Leaflets mostly elliptical, broadest at or near the middle; appendage free for about 1.8-2.2 mm., its hairs straight or nearly so; ovary and gynophore densely long-pilose; shrub or small tree up to 5 meters tall. 14. *S. subcymosa*

9. Leaflets mostly narrowly obovate, broadest above the middle; appendage free for about 0.8–2.0 mm., its hairs somewhat curled and twisted; ovary and gynophore short-pilose; arborescent shrub, or tree up to 20 meters tall.....13. *S. cuneata*
2. Petals mostly 20–35 mm. long; filaments 12.5–25 mm. long; appendages 10–20 mm. long. (*Grandiflorae*)
3. Suffruticose; leaves all basal; petals 3 cm. long or more; filaments about 25 mm. long; appendages about 18–20 mm. long.....24. *S. salubris*
3. Shrub or tree; cauline leaves present; flowers variable but mostly a little smaller than in *S. salubris*
4. Leaflets 2–6 pairs.
 5. Leaflets puberulous above, densely velvety beneath; shrub about 1 meter high.20. *S. trichilioides*
 5. Leaflets essentially glabrous.....21. *S. Pohliana*
4. Leaflets 7–many pairs.
 5. Leaflets mostly 10–15 pairs, commonly but not always tipped with a conspicuous, indurated, black or dark brown subglobose gland, puberulous on the midrib above and occasionally sparsely so below, otherwise glabrous; arborescent shrub or slender tree up to 15 meters tall.....23. *S. cedron*
 5. Leaflets 7–11 pairs, merely acuminate, not gland-tipped, or only inconspicuously so, the midrib and main veins puberulous beneath, the lower surface sometimes also sparsely puberulous; arborescent shrub 2–4 meters tall.....22. *S. Maiana*

INDIVIDUAL TREATMENT OF THE SPECIES

1. *SIMABA CUSPIDATA* Spruce ex Engl. in Mart. Fl. Bras. 12²: 212. 1874.
 1a. ***Simaba cuspidata* var. *typica*** Cronquist, nom. nov.

Simaba cuspidata Spruce ex Engl. in Mart. Fl. Bras. 12²: 212. 1874.

Type: *Spruce 1751*, “*Alto Amazonas ad oram septentrionalem fluminis Amazonum ad ostium fl. Rio Negro*,” (F-photo, NY, NY-photo).

Distribution: Amazonas, Brazil, where reported by Ducke to be common in the forest; reported by Engler from Surinam.

- 1b. ***Simaba cuspidata* var. *nigrescens*** (Engl. in Mart.) Ducke ex Cronquist, comb. nov.

Simaba nigrescens Engl. in Mart. Fl. Bras. 12²: 213. 1874.

Type: *Riedel 1604*, “*in provinciae Para umbrosis arenosis pr. Santarem*.”

Illustrations: Mart. Fl. Bras. 12²: t. 41. 1874.

E. & P. Nat. Pfl. 3⁴: 214. 1896.

Distribution: Para, where, according to Ducke, it is “*limitée à la petite forêt sèche de la lisière de campos et de plages sablonneuses*.”

BRAZIL: *Riedel s.n.*, (G-probably an isotype). Para. *Ducke 8480*, (US), 8868, (US), 14109, (US); *Huber 2156*, (F-photo and fragment, US).

Ducke, speaking of *S. cuspidata* and *S. nigrescens*, says, “*Les formes de transition entre les deux sont frequentes et tres evidentes . . .*,” and refers to “*var. nigrescens* (Engl.) Ducke.” However, since he gives neither a description nor a reference to a previously published description, the combination is not validly published according to the rules. It is therefore here published as Ducke ex Cronquist.

This species is very closely related to *S. guianensis* Aubl. and may not be distinct. The only obvious differences lie in the flowers, and there is no real discontinuity. I believe, however, that two entities are involved, and since each appears to have two leaf forms worthy of varietal recognition, they may for the present at least be retained as species.

2. *SIMABA GUIANENSIS* Aubl. Pl. Gui. 1: 400. 1775.

2a. *Simaba guianensis* var. *typica* Cronquist, nom. nov.

Simaba guianensis Aubl. Pl. Gui. 1: 400. 1775.

Aruba guianensis Aubl. Pl. Gui. 1: 293. 1775.

Quassia crocea Vahl. Eclog. Am. 3: 12. 1806.

Simaba Aruba A. St. Hil. ex DC. Prodr. 1: 734. 1824.

Zwingeria Aruba Spreng. Syst. 2: 319. 1825.

Quassia guianensis D. Dietr. Syn. Pl. 2: 1416. 1840.

Quassia Aruba D. Dietr. Syn. Pl. 2: 1416. 1840.

Type: *Aublet s.n.*, "in sylvis Orapu," French Guiana.

Illustrations: Aubl. Pl. Gui. t. 115, 153. 1775.

Mém. Mus. Par. 12: t. 27, part 45b. 1825.

Distribution: Known from French Guiana, Para and Amazonas, Brazil, and British Guiana.

BRAZIL: Amazonas. Basin of Rio Madeira. *Kuhlman* 18981, (US). Para. Basin of Rio Tapajos. *Kuhlman* 18944, (US). BRITISH GUIANA: *Wood s.n.* (Kr. Herb. #16722).

2b. *Simaba guianensis* var. *ecaudata* Cronquist, var. nov.

Foliolis apice rotundis emarginatus non attenuatis, ceteris similis var. typico.

Type: *Froes* 11724, low land, high forest, Island of Sao Luiz, Maranhao, Brazil, January, 1940, (NY); isotypes, (A, MO). Cotype: *Froes* 11725, fruiting specimens, same time and place as #11724, (A, MO, NY).

Distribution: Known only from the type and cotype collections, Maranhao, Brazil.

The type of var. *ecaudata* has longer filament appendages than any other specimens of the species available to me (3.4–3.6 mm.), but this is probably merely an individual difference.

3. *SIMABA MULTIFLORA* A. Juss. Mém. Mus. Par. 12: t. 27. 1825.

Simaba foetida Benth. Jour. Bot. & Kew Misc. 3: 370. 1851.

Simaba angustifolia Benth. loc. cit.

Simaba guianensis var. *Schomburgkiana* Engl. in Mart. Fl. Bras. 12²: 212. 1874.

Simaba guianensis var. *angustifolia* Engl. in Mart. loc. cit.

Simaba multiflora var. *Schomburgkiana* Sandw. Kew Bull. 1929: 81. 1929.

Simaba multiflora var. *angustifolia* Sandw. loc. cit.

Type: A figure published by Jussieu, without reference to a specimen. The figure may perhaps have been taken from the *Martin* collection cited below.

Local names: Cajurana, ciruelito, pitombeira, tambaqui.

Distribution: Widespread and common along streambanks and periodically inundated lowlands, from Loreto, Peru, to Para, Brazil, north to French Guiana, Venezuela, and Trinidad.

PERU: Loreto. *Poeppig* 2897, (F, US); *Schunke* 254, (F). BRAZIL. Amazonas. Basin of Rio Salimoes. *Kuhlman* 18977, (US). Basin of Rio Negro. *Spruce* 1128, (G, NY), 1129, (F-photo, NY-photo). Para. *Capucho* 532, (F); *da Costa* 312, (F); *Ducke* 10260, (US), 11739, (US); *Spruce* 507, (F-photo, NY, NY-photo). FRENCH GUIANA: *Martin* s.n., (F). DUTCH GUIANA: *Haslman* 141, (G, NY); *Schweinitz* s.n., (NY). BRITISH GUIANA: *Wood* s.n., (Kr. Herb. #16221). VENEZUELA: Bolivar. *Williams* 13311, (A, F). TRINIDAD: *Alexander* 6943, (NY).

This widespread species was confused by Engler with *S. guianensis*, which is readily separated by the appendages of the filaments, size of the inflorescence, and shape of the leaflets. The situation was rectified in 1929 by Sandwith.

S. multiflora has three forms of leaflets, by which it might conceivably be separated into varieties, but there is frequently considerable variation even on a single branch as represented on a herbarium sheet, and Ducke reports that plants with various forms of leaflets grow together without any geographic segregation. It seems unwise, at present, to attempt to separate these phases as varieties.

It will be noted that this species is found in the lowlands that are subject to flooding, while its relatives, *S. guianensis* and *S. cuspidata*, grow on higher and drier ground.

4. SIMABA CRUSTACEA Engl. in Mart. Fl. Bras. 12²: 211. 1874.

Type: *Riedel* 1490, "in sylvis prov. do Matto Grosso," (F-photo).

Distribution: Known only from the type collection.

The narrowly obovate rounded leaflets of this species, as a photograph of the type shows, are much like those of *S. orinocensis* and some forms of *S. multiflora*, whence Engler placed it in the *Tenuiflorae*, its flowers being yet unknown. Probably it is a distinct species, but it may be merely a form of *S. multiflora*.

5. SIMABA ORINOCENSIS H. B. K. Nov. Gen. et Sp. 6: 18. 1823.

Zwingera orinocensis Spreng. Syst. 2: 319. 1825.

Quassia orinocensis D. Dietr. Syn. Pl. 2: 1416, 1840.

Type: *Humboldt & Bonpland* s.n., "crescit in arenosis, calidis, prope Carichana. (Miss. del Orinoco)."

Illustration: H. B. K. Nov. Gen. et Sp. 6: t. 514. 1823.

Distribution: Known only from the type collection.

This species is evidently related to *S. multiflora*, from which it is separated by the long gynophore, very short appendages of the filaments, and slender asymmetrical fruit.

6. SIMABA OBOVATA Spruce ex Engl. in Mart. Fl. Bras. 12²: 210. 1874.

Type: *Spruce* 3340 (cited by Engler as 5340), "ad flumina Casiquiari,

Vasiva, et Pacimoni," Amazonas, Venezuela, (NY, NY-photo, F-photo).
Distribution: Lowlands of northern Amazonas, Brazil, and Amazonas, Venezuela.

BRAZIL: Amazonas. Basin of Rio Tonantins. *Ducke* 20514, (US). Basin of Rio Negro. *Ducke* 187, (A, F, MO, NY, US), 7113, (US). VENEZUELA. Amazonas. *Spruce* 3347, (F-photo, NY, NY-photo).

This species is evidently related to *S. multiflora*, differing chiefly in its solitary leaflets.

7. ***Simaba monophylla*** (Oliv.) Cronquist, comb. nov.

Simarouba monophylla Oliv. Ic. Pl. 14: t. 1387. 1882.

Type: *G. S. Jenman* 1043, Kaietur Savannah, Potaro River, British Guiana, Sept.-Oct., 1881 (Georgetown Botanic Garden, British Guiana).

Distribution: Known only from the type collection.

Although obviously related to *S. obovata*, this species is clearly distinct. In addition to the characters given in the key, it differs from *S. obovata* in its stouter pedicels, and longer and relatively narrower leaflets, which look much like the leaflets of *Simarouba amara* var. *typica* in shape and texture. The twigs on the single sheet available are a bright and shiny black, which may be a characteristic feature, or may be due merely to the vicissitudes of preparation.

8. ***SIMABA PARAENSIS*** Ducke, Arch. Jard. Bot. Rio de Jan. 4: 195. 1925.
Type: *Ducke* 18947, "in silvis primariis non inundatis civitate Para; prope Obidos, October 5, 1915."

Distribution: Amazonas and Para, Brazil, on "terra firma."

BRAZIL: Amazonas. Basin of Rio Purus. *Krukoff* 5276, (A, MO, NY, US). Para. *Siqueira* 18948 (= 9654), (F-photo, NY-photo, US).

This species may well represent the basal part of the section *Floribundae*.

9. ***SIMABA FLORIBUNDA*** A. St. Hil. Mém. Mus. Par. 10: 277. 1823.

Zwingera floribunda Spreng. Syst. 2: 315. 1825.

Quassia floribunda D. Dietr. Syn. Pl. 2: 1416. 1840.

Type: *St. Hilaire* s.n., "in locis siccis prope urbem Villa-do-Fanado in Minas-novas," Minas Geraes, Brazil.

Illustration: A. St. Hil. Pl. Rem. Bres. 1: t. 10. 1824.

Distribution: Minas Geraes and Matto Grosso, Brazil.

10. ***SIMABA GLABRA*** Engl. in Mart. Fl. Bras. 12²: 218. 1874.

Simaba glabra subsp. *trijuga* Hass. Repert. Sp. Nov. 10: 347. 1912.

Simaba glabra subsp. *trijuga* var. *emarginata* Hass. loc. cit.

Simaba glabra subsp. *trijuga* var. *inaequilateriala* Hass. loc. cit.

Type: *Riedel* 483, "in prov. S. Paulo ad Rio Pardo," (F-photo, G.).

Illustration: Mart. Fl. Bras. 12²: t. 43. 1874.

PARAGUAY: *Hassler* 10569, (A), 10569A, (A).

The specimens on which Hassler's proposed segregates are based look very much like the type collection of the species.

11. *SIMABA WARMINGIANA* Engl. in Mart. Fl. Bras. 12²: 217. 1874.

Type: *Warming* 2466, "in prov. Minas Geraes in campis ad Lagoa Santa," (F-photo, NY-photo).

Distribution: Minas Geraes and Bahia, Brazil.

BRAZIL: Minas Geraes. *Mello Barreto* 754, (F).

12. *SIMABA FERRUGINEA* A. St. Hil. Mém. Mus. Par. 10: 277. 1823.

Zwingeria ferruginea Spreng. Syst. 2: 319. 1825.

Simaba bahiensis Moric. Mem. Soc. Phys. Gen. 7: 251. 1836.

Quassia ferruginea D. Dietr. Syn. Pl. 2: 1416. 1840.

Homalolepis Blanchetii Turcz. Bull. Soc. Nat. Moscow 21¹: 575. 1848.

Simaba Blanchetii Turcz. loc. cit. 31¹: 444. 1858.

Simaba ferruginea var. *Blanchetii* Engl. in Mart. Fl. Bras. 12²: 215. 1874.

Type: *St. Hilaire* s.n., "inveni in campis intersitis arboribus retortis, in deserto occidentali (Certao) provinciae Minas-Geraes prope praedium Macauba," (F-fragment).

Illustrations: Mem. Soc. Phys. Gen. 7: t. 9. 1836, (as *S. bahiensis*).

St. Hil. Fl. Bras. Merid. 1: t. 14. 1825.

Local name: Calunga.

Distribution: Minas Geraes to Piauh, Brazil.

BRAZIL: *St. Hilaire* 1898, (F-fragment). Goyaz. *Burchell* 6450, (G). Piauh. *Gardner* 2514, (NY).

Bahia. *Blanchet* 1666, (NY), 3143, (F, MO, NY).

Simaba Blanchetii has slightly larger flowers, and a larger and more congested inflorescence than *S. ferruginea*, but the differences are minor and not entirely correlated, so that the two are certainly not distinct species. Perhaps one might reasonably treat *S. Blanchetii* as a variety of *S. ferruginea*, as Engler has done, but I think the burden of proof rests upon those who would recognize it as a taxonomic entity of any sort.

13. *SIMABA CUNEATA* A. St. Hil. & Tul. Ann. Sc. Nat. II, 17: 138. March, 1842.

Simaba laevis Casar. Nov. Stirp. Bras. 10. May, 1842.

Type: *Riedel* 1032, "in silvis maritimis prope Rio de Janeiro, Brazil," (F-fragment).

Local names: Quina do matto, quina quina.

Distribution: Rio de Janeiro, Bahia, and probably Minas Geraes, Brazil.

BRAZIL: *Riedel* s.n., (F, G). Rio de Janeiro. *Riedel* 1000, (F-photo, NY-photo). Minas Geraes. *Glaziov* 12929, (F). Bahia. *Froes* 17, (Kr. Herb. #12651); *Froes* 56, (Kr. Herb. 12691).

The floral differences between this and *S. subcymosa* are minor, but the shape of the leaflets, while somewhat variable, is distinctive. Also *S. cuneata* is commonly a small tree, while *S. subcymosa* was described as an "*arbuscula tortuosa*."

14. *SIMABA SUBCYMOSA* A. St. Hil & Tul. Ann. Sc. Nat. II, 17: 137. 1842.
Type: *Guillemin 727*, "*in monte Corcovado, prope Rio de Janeiro*," Brazil, (F, F-photo, NY).

Distribution: Rio de Janeiro, Brazil.

BRAZIL: Rio de Janeiro. *Glaziou 17974*, (F); *Kuhlman 815*, (US).

This species is closely related to *S. suaveolens*, differing in the much more ample inflorescence, more hairy gynophore, and shorter free portion of the appendage of the filaments.

15. *SIMABA SUAVEOLENS* A. St. Hil. Mém. Mus. Par. 10: 278. 1823.

Zwingera suaveolens Spreng. Syst. 2: 319. 1825.

Quassia suaveolens D. Dietr. Syn. Pl. 2: 1416. 1840.

Type: *St. Hilaire 3*, "*in sylvis primaevae montis dictis Piriquito prope Itabira-de-mato-dentro (provincia Minas-Geraes)*," Brazil, (F-photo).

Illustrations: Mem. Mus. Par. 10: t. 11A. 1823.

St. Hil. Pl. Rem. Bras. t. 11A. 1824.

Local name: Piriquito.

Distribution: Known only from the type collection in Minas Geraes, Brazil.

16. *SIMABA PRAECOX* Hassler, Bull. Herb. Boiss. II, 7: 723. 1907.

Type: *Hassler 9497*, "*in campis pr. Yhu*," Paraguay, (F-photo).

Distribution: Known only from the type locality.

17. *SIMABA SUFFRUTICOSA* Engl. in Mart. Fl. Bras. 12²: 213. 1874.

Type: *Riedel 2471*, "*in prov. Minarum campis pr. Uberaba alibique in hac prov.*," (G).

Illustrations: Mart. Fl. Bras. 12²: t. 42. 1874.

E. & P. Nat. Pfl. 3⁴: 214. 1896.

Local name: Calunga.

Distribution: Minas Geraes and Goyaz, Brazil.

18. *SIMABA INSIGNIS* A. St. Hil. & Tul. Ann. Sc. Nat. II, 17: 137. March, 1842.

Simaba glandulifera Gardn. Lond. Jour. Bot. 1: 169. April, 1842.

Simaba longifolia Casar. Nov. Stirp. Bras. 9. May, 1842.

Type: *Gardner 20*, "*in mont. Serra da Estrella, prope Rio de Janeiro*," (F-fragment & photo, G, NY).

Distribution: Rio de Janeiro, Brazil.

Local names: Calunga, parahyba-mirim, simarouba-mirim.

BRAZIL: *Nadeaud s.n.*, in 1862, (F). Rio de Janeiro. *Casaretto s.n.*, (F-fragment); *Gardner 19* (NY); *Helmreichen 57*, (F); *Miers 3805, 3806*, (US).

Three names were published for this species in three consecutive months, two of them based on the same collection. Although *Simaba insignis* A. St. Hil. & Tul. was based on Gardner's plant, the name appears to have been published a month before Gardner's name, *S. glandulifera*, and thus must be adopted. Although it is kept in the section *Floribundae* by the size of its flowers, this species resembles *S. cedron* in some respects, and is probably related to that species.

19. *SIMABA INTERMEDIA* Mansfeld, Notizbl. Bot. Gart. Berl. **9**: 39. 1924.

Type: *Luetzelburg 1504*, Goyaz, Brazil, August, 1922, (F-photo, NY-photo).

Distribution: Bahia and Goyaz, Brazil.

20. *SIMABA TRICHILIOIDES* A. St. Hil. Mém. Mus. Par. **10**: 279. 1823.

Zwingeria trichilioides Spreng. Syst. **2**: 315. 1825.

Quassia trichilioides D. Dietr. Syn. Pl. **2**: 1416. 1840.

Type: *St. Hilaire s.n.*, "in campis occidentalibus provinciae Minas-Geraes . . . prope urbem Paracatu," (F-photo & fragment).

Illustrations: Mém. Mus. Par. **10**: t. 11B. 1823.

A. St. Hil. Pl. Rem. Bres. t. 11B. 1824.

Local names: Guardamor, calunga.

Distribution: Minas Geraes and Matto Grosso to Piahy and Ceara, Brazil.

BRAZIL: *Pohl 2222*, (F). Matto Grosso. *Kuntze s.n.*, (NY); *Malme 1755*, (G, US). Goyaz. *Ra-witscher s.n.*, (Kr. Herb. #16416). Piahy. *Gardner 2515*, (G). Ceara. *Ule 9045*, (US).

21. *SIMABA POHLIANA* Boas, Beih. Bot. Centr. **29**¹: 337. 1913.

Type: *Pohl s.n.*, Brazil.

Distribution: Goyaz, and perhaps elsewhere in Brazil.

BRAZIL: *Pohl 1900*, (F, US). Goyaz. *Burchell 7593*, (G), 7986, (G).

The leaflets of this species frequently have a well-developed, dark, indurated gland at the tip, as in *S. cedron*.

22. *SIMABA MAIANA* Casar. Nov. Stirp. Bras. **10**. 1842.

Type: *Casaretto 1257*, "in sylvulis arenosis maritimis . . . prope Rio de Janeiro," (F-photo and fragment).

Distribution: Rio de Janeiro to Piahy and Maranhao, Brazil.

BRAZIL: Rio de Janeiro. *Riedel s.n.*, (NY); *Riedel 999*, (F-photo). Piahy. *Pohl 745d* (= 4306), (F).

There is considerable variation in the length of the free portion of the appendage in the group of species which includes *S. salubris*, *S. cedron*, *S. Maiana*, *S. Pohliana*, and *S. trichilioides*, but more material is needed to determine the limits of variation before the taxonomic worth of that character can be established.

23. SIMABA CEDRON Planch. Lond. Jour. Bot. 5: 566. 1846.

Quassia cedron D. Dietr. Syn. Pl. 2: 1416. 1840.

Type: *Purdie s.n.*, "ad ripas fluminis Magdalenae, prope pagum Sao Paulo, Novae Granadae."

Illustrations: Jour. Bot. & Kew Misc. 2: t. 11. 1850.

E. & P. Nat. Pfl. 3⁴: 214. 1896.

Local names: Cedron, vela de muerto, (Central America); pau de gafanhoto, (Brazil).

Distribution: Apparently native to the Amazon basin; now widely cultivated in Brazil, northern South America, and Central America.

BRAZIL: *Archer s.n.*, (Kr. Herb. 16266). Amazonas. Basin of Rio Madeira. *Krukoff* 6645, (A, NY, US). Basin of Rio Negro. *Killip & Smith* 30203, (NY). Para. *Ducke* 4875, (US), 4908, (US). Maranhao. *Froes* 26, (US), 1867, (A, MO, NY), 11958, (NY). FRENCH GUIANA: *Melinon* 326, (US). BRITISH GUIANA: *Bailey* 201, (G); *de la Cruz* 2222, (NY), 2642, (NY), 3537 (NY); *Hitchcock* 17300, (NY, US); *Jenman* 4239, (US), 4141, (US); *Persaud* 133, (F, NY); *Tutin* 161, (US), 373, (US); *Wood s.n.*, (Kr. Herb. #15988Y, #16168). VENEZUELA: *Broadway* 770, (NY, US). Bolivar. *Williams* 11320, (F, US), 11584, (F, US). COLOMBIA: *Dawe* 425, (US). Boyaca. *Haught* 2632, (A). TRINIDAD: *Britton & Hazen* 1187, (NY, US); *Dean s.n.*, (Kr. Herb. #16235); *Trinidad Botanical Garden* 3, (US). PANAMA: *Pittier* 6569, (NY, US). COSTA RICA: *Brenes* 750 (= 12271), (F), 810 (= 12331), (F). *Brenes & Quiros-Calvo* 662, (F); *Tondus* 94, (US), 6987, (US), 9948, (NY, US); *Valerio* 395, (F); *Valerio & Rodriguez s.n.*, (Kr. Herb. #16199). EL SALVADOR: *Calderon* 2348, (F).

24. SIMABA SALUBRIS Engl. in Mart. Fl. Bras. 12²: 219. 1874.

Type: *Riedel* 585, "in prov. Sao Paulo in campis ad Rio Pardo," (G).

Illustration: Mart. Fl. Bras. 12²: t. 44. 1874.

E. & P. Nat. Pfl. 3⁴: 214. 1896.

Local names: Calunga, calumba.

Distribution: Known only from the type collection.

EXCLUDED SPECIES

Simaba bicolor Zucc. Abh. Akad. Muench. 1: 353. 1829-30 = *Decatropis bicolor* (Zucc.) Radlk.

Simaba indica Baill. Hist. Pl. 4: 440. 1873. = *Samadera indica* (Baill.) Gaertn.

Simaba quassioides D. Don. Prod. Fl. Nep. 248. 1802. = *Picrasma quassioides* (D. Don.) Benn.

Simaba undulata Guill. & Perr. Fl. Seneg. Tent. 1: 136. 1830-1833. = *Hannoa undulata* (Guill. & Perr.) Planch.